

**EXERCISES IN LOGIC
AND SCIENTIFIC METHOD**

By the same Author

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EXERCISES IN LOGIC AND SCIENTIFIC METHOD

BY

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PREFACE TO THE NEW EDITION

THE number of questions and exercises has been considerably increased for this edition, and the needs of more advanced students have also been studied. In the interests of private students many changes have been made in arrangement, etc. At the urgent request of many correspondents a key to the exercises is being prepared and will be published shortly *

A. WOLF.

UNIVERSITY OF LONDON,
March 1926.

* Now available.

PREFACE TO THE FIRST EDITION

WHETHER or no an ounce of practice is worth a pound of theory, it is certainly a pity to spoil a pound of theory for want of an ounce of practice. The proportion of Logic students who are unable to deal with a concrete argument is amazingly large. What would one think of a student of Biology who could talk about Vitalism, etc., but could not identify common plants and animals? Unfortunately this kind of thing is not unknown among the votaries of Logic. The chief cause of this deplorable condition is insufficient practice in the analysis of concrete arguments. This little book is intended to help to improve matters. In exercises H, J, and L¹ will be found numerous examples of the kind most needed. At the same time the rest of the ground usually covered in a first year's course is provided for in the other exercises.

This compilation is the fruit of many years' teaching and examining. Most of it was printed privately some years ago for the use of my own students. It is now published in the hope that it may be of service to a wider circle, and help to make the study of Logic as fruitful as it ought to be.

¹ Groups I, K, and M, in the New Edition.

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EXERCISES IN LOGIC AND SCIENTIFIC METHOD

GROUP A

SCOPE OF LOGIC

1. " People can reason without the help of Logic." Comment on this statement, and indicate what you take to be the general aim of Logic.

2. Explain the difference between the grammatical, the logical, and the rhetorical aspects of an argument.

3. Explain the statement that Logic is concerned with the *validity* of inferences, not with their *truth*. Is Logic indifferent to truth ?

4. Compare the logical with the psychological way of studying reasoning.

5. What is meant by describing Logic as a *normative* science ?

6. Explain the following statement : " The object of Logic is to ascertain how we come by that portion of our knowledge which is not intuitive : and by what criterion we can, in matters not self-evident, distinguish between things proved and things not proved."

7.* Describe some process of reasoning and indicate the principal factors involved.

8.* "Logic is most comprehensively and least controversially defined as the analysis and criticism of thought."

Carefully discuss this definition and indicate what distinction you would draw between Logic and Epistemology on the one hand, and Logic and Science on the other. *

9.* Consider the relation of Logic to Metaphysics, and discuss the view that "Logic like other special sciences, neither can struggle, nor should it attempt to struggle, with final difficulties."

10.* Give a critical account of the two extreme views concerning the relation of Logic to Psychology, and comment on the criticism that "both involve the same psychologism."

* Some of the more difficult questions are marked with an asterisk.

GROUP B

TERMS.

1. Distinguish between a *word*, a *name*, and a *term*.
2. Distinguish between a *sentence*, a *proposition*, and a *judgment*.
3. Why is it sometimes necessary to take account of context when interpreting terms and propositions?
4. Explain the following expressions: *meaning*, *intension*, *extension*, *connotation*.
5. Is it possible to know the extension of a term without its connotation, or vice versa?
6. Are all singular terms non-connotative?
7. Distinguish carefully between *general* terms and *universal* terms, and show how this distinction affects the question as to whether abstract terms may be general.
8. What is meant when it is maintained that Proper Names have no *connotation* although they are richest in *meaning*?
9. Comment on the use of the word *abstract* in the following passage: "In economic science we have to deal with abstract terms—with wealth, with value, with wages, with labour, with capital,

with instruments of production, and with phrases such as these."

10. How do you distinguish an *absolute* from a *relative* term?

11. Explain the difference between the *collective* and the *distributive* use of terms, and illustrate your answer from the following lines:—

All men find their own in all men's good,
And all men join in noble brotherhood.

12. Are abstract terms ever singular in the same sense in which concrete terms are sometimes singular? Compare the distinction between general and singular concrete terms with the distinction between more and less universal abstract terms.

13. Explain the relation between *contradictory* terms, *contrary* terms, *incompatible* terms.

14. What is meant by *ambiguity*? Show clearly that each of the following words is ambiguous: *some*, *all*, *or*.

15. Give the contrary and the contradictory terms of each of the following, if possible: (a) the first servant of the state, (b) ultimate principles, (c) higher studies, (d) either superior or inferior, (e) neither better nor worse, (f) both more profitable and more honourable.

GROUP C

PREDICABLES, CATEGORIES, ETC.

1. Give an account of the Predicables.
2. Explain the nature and function of Definition.
3. State the nearest genus and the differentia of each of the following terms : Dictionary, Encyclopedia, Bank, Bill of Exchange, Science, Logic, Economics, Democracy, Socialism, Syndicalism.
4. What Predicables do the following statements exemplify ?—
 - (a) Parallel lines are lines which never meet.
 - (b) Hydrogen is the lightest body known.
 - (c) The nerves are conductors of impressions.
 - (d) Art critics are artists who have failed.
 - (e) A critical person when he lights on an interesting statement begins by suspecting it.
 - (f) The area of a circle is the largest that can be enclosed by a perimeter equal to its circumference.
 - (g) A gain in power is generally a loss in morals.
5. Discuss the distinction between *nominal* and *real* definitions.
6. Explain and illustrate the difference between *substantial* and *genetic* definitions.

7. How is it that the definition of a term changes from time to time ?

8. Explain the nature of Division and Classification, and their relation to Definition.

9. What is Division by Dichotomy ? Comment on the following statement : " We may regard division by dichotomy as a formal process, but only on the understanding (a) that the principle of division is given as well as the genus to be divided ; (b) that this division is not assumed to be more than hypothetical so far as concerns the existence of the resulting sub-classes."

10. Divide by dichotomy the term Pauper, using the following *fundamenta divisionis* : skilled, able-bodied, male, native.

11. Give a scheme of division to incorporate the following among others : general terms, collective terms, many-worded terms, abstract terms, relative terms.

12. Montesquieu divided Governments into Despotisms, Monarchies, and Republics. Lord Morley has criticized Montesquieu for employing two principles of division. Explain. Is it never permitted to use two principles of division ?

13. Compare the popular with the logical use of *category* and *predicament*.

14. Discuss the distinction between natural and artificial classifications.

15. Comment on the use of the term *telegraph* in the following passage : " The Mayor of Fairborough protested against the multiplication of overhead telephone wires in his borough. He

maintained that the Postmaster-General had no authority to put them up at all, as the Act of Parliament only authorized him to put up *telegraph* wires. The Postmaster-General replied that for the purpose of that Act *telegraph* included *telephone*."

16. The question whether or not a shovel is a spade was gravely discussed by half a dozen lawyers at Omaha before the President of the Board of the United States General Appraisers. If shovels are not spades, importers must pay a tariff of 20 per cent. on them. But if a shovel is a spade, it can enter the United States free of duty, as agricultural implements are exempted.

What point of logical interest does the above question raise?

17. How are definitions affected by the purposes for which they are intended? Comment on the following statement: "How is one to distinguish between *raw materials* and *manufactured goods*? Tariff Reformers distinguish them by constituencies. Leather, for instance, is a raw material in Northampton, but a manufactured article in Bermondsey. And so with other articles."

18. Explain and discuss the contention that a genus is richer in *content*, as well as in *extent*, than any one of its species.

19. In an affirmative proposition it is permissible to replace the given predicate by its genus, but not by one of its species. Why?

20. The subject of a proposition may be replaced by one of its species, but not by its genus. Why?

21.* Compare Aristotle's with Kant's account of the Categories.

22.* State and discuss Mill's criticisms of the Aristotelian list of Categories.

23.* Explain the following statement: "The logical divisions of terms rest on differences of things, as we apprehend them; this is apt to be overlooked when the subject is approached from the side of names; Aristotle's doctrine of Categories has this advantage, that throughout it fixes our attention on things."

24.* To what extent and in what way do (a) the Classifications of Terms, (b) the doctrine of Categories, and (c) the doctrine of Predicables all deal with the same kind of problem?

25.* Distinguish between the logical and the mathematical sense of "definition," and try to account for the difference in requirement.

GROUP D

LAWS OF THOUGHT

1.* Consider some of the various formulations of the ultimate Laws of Thought, and indicate and justify your preference for some of them.

2.* Critically examine some of the most important formulations of the Principle of Identity, and discuss the view that "if the axiom of Identity is not just as much an axiom of Difference, then it is not a principle of judgments at all."

3.* How do axioms differ from postulates? What are the most important axioms and postulates of Logic? Give reasons for your views.

4.* Give an account of the way in which the ultimate principles of deductive reasoning and the axioms of mathematics are arrived at.

5.* Discuss the view that the Laws of Thought constitute a negative test of truth, and consider it with special reference to the Principle of Sufficient Reason.

GROUP E

THEORY OF JUDGMENT AND IMMEDIATE INFERENCE

1. Explain what is meant by (a) a judgment, (b) a proposition.

2. Enumerate the principal kinds of judgment and give a brief account of each kind.

3. Explain the logical distinction between the subject and the predicate of a categorical proposition. Compare it with the corresponding grammatical distinction.

4. What is meant by saying that in judgment there is always implied a reference to objective fact?

5. What is meant by the distinction between *Form* and *Matter* in thought? Does the logician deal with both?

6. Express the substance of the first two sentences in the form of hypothetical and categorical propositions, and of the last two in hypothetical and disjunctive propositions:—

(a) British subjects are either British born or naturalized.

(b) Lines are either straight or curved.

(c) All approved candidates must satisfy certain conditions.

- (d) Books that cannot be reviewed favourably should not be reviewed at all.

7. Discuss the relation between the first and second proposition in each of the following pairs :—

- (a) If X , then Y ; either Y or not X .
- (b) Either X or Y ; neither X nor Y .
- (c) Both X and Y ; neither X nor Y .
- (d) Both X and Y ; either not X or not Y .
- (e) Either X or Y ; either not X or not Y .

✓8. Explain the distribution of terms in A, E, I, and O propositions.

✓9. Give the Square of Opposition with a brief explanation.

10. Define Contradictory and Contrary Opposition in such a way as to apply to propositions which do not have the same subjects and the same predicates.

11. What is meant by *eduction*? Give a symbolic scheme of the principal kinds of eduction.

12. Distinguish between the Converse and the Correlative of a proposition.

13. What propositional forms cannot be converted, at all, or not simply? State the reasons, and give examples.

14. Show that it cannot be true both that "no statesmen are competent" and that "no one who is incompetent is a statesman."

15. If it is true that "all aeroplanes are subject to the law of gravity," does it follow that "some things that are not aeroplanes are not subject to the law of gravity"? Give reasons for your answer.

16. What is meant by modality? State exactly

the logical significance of the expression " may " in each of the following propositions :—

- (a) This story may be true.
- (b) Frosts may occur in June.
- (c) A man may smile and smile and be a villain.
- (d) A Nonconformist clergyman may sit in Parliament.
- (e) A Government official may not send information to the Press.

17. " P implies Q ." Taking P and Q to stand for propositions, state what is meant by "*implies*."

Formulate the proposition " P implies Q " as (i) a hypothetical, (ii) a disjunctive proposition.

18. Compare Immediate Inference by Added Determinants with that by Complex Conception. To what errors are they both liable?

19.* "The aim of a classification of judgments should be to exhibit them as progressive stages in the development of the understanding." How far can this be done, and why does the traditional classification fail to do it?

20.* Discuss different opinions that have been held as to the modality of judgments.

21.* "Hypothetical judgments are the expression of doubt." "Hypothetical judgments are the expression of laws." Discuss these views.

22.* Examine the view that particular propositions do, whilst universal propositions do not, imply the existence of their subjects.

23.* Explain the "difference between the particular judgment interpreted of individuals not enumerated, and the particular judgment interpreted of conditions not fully specified."

24.* Explain the relation of judgments to ideas, and examine the contention that not only is judgment impossible without ideas, but that we cannot judge till we use ideas *as* ideas.

25.* Discuss the nature of judgments of relation, and distinguish between (a) symmetrical and asymmetrical, (b) transitive and intransitive, and (c) "one-one" and "one-many" relations.

26.* "All judgments are assertions of existence." Discuss this, and consider the significance or meaning of the so-called existential judgment.

27.* "The reduction of judgment of possibility to possibility of judgment is an attempt to take refuge in psychology from a logical difficulty."

28.* What is a "propositional function," and why has it been introduced into Logic?

29.* Discuss the equational interpretation of propositions.

30.* Give an account of *impersonal* propositions and their significance in the theory of judgment.

31.* What is meant by a "floating idea"? Is there such a thing?

32.* Explain the view that *meaning* is what distinguishes *ideas* from *images*.

33.* Show that the same image may have different meanings; and explain what it is that determines the meaning on each occasion.

34.* What is meant by a "universe of discourse," and why must it be taken into account?

35.* Explain the conception of existence in other "universes" than that of physical reality, and discuss the need of such a conception.

GROUP F

EXERCISES IN IMMEDIATE INFERENCE

EXPRESS the following^f statements in the recognized categorical forms, and add the *contradictory*, the *contrary*, the *obverse*, the *converse*, the *contrapositive*, and the *inverse*, if possible. Check your procedure by reference to symbols.

1. He is a bad workman who grumbles at his tools.
2. Blessed is he who carries with him an ideal.
3. Home-keeping youths have ever homely wits.
4. The strong are strongest when they stand alone.
5. The seer is always solitary.
6. Birds of a feather flock together.
7. A merry heart goes all the way.
8. Our sincerest laughter with some pain is fraught.
9. Who is not wise after the event ?
10. Those who reckon without Providence have to reckon twice.
11. It is always a mistake to govern overmuch.
12. Like seeks like.
13. Too many cooks spoil the broth.
14. The best things are disgusting when thrown at our heads.
15. To be busy is half-way to being happy.
16. Even the weariest river winds somewhere safe to sea.

EXERCISES IN IMMEDIATE INFERENCE 25

17. It's easy finding reasons why other folks should be patient.

18. Large Empires often breed small citizens.

19. He who hath not a dram of folly in his mixture hath pounds of much worse matter in his composition.

20. Not all the reparations in the world can undo the evils of warfare.

21. Truth and physic are never well received.

22. One is never really beaten unless he is discouraged.

23. The fullest sympathy is never felt by those who are lacking in imagination.

24. Two of a trade never agree.

25. Words without thoughts never to heaven go.

26. Not heaven itself upon the past has power.

27. He is not a properly educated man who cannot look at both sides of a question.

28. Nothing else can be substituted for honesty.

* 29. Men sometimes are masters of their fate.

30. It is often more troublesome and costly to enforce justice than to bear an injustice.

31. Unconscious cruelty often goes with a lack of imagination.

32. Victory obtained in a wrong cause may be the most awful calamity that can befall a nation.

33. The race is not always to the swift.

34. Those who win most of the battles may yet lose the war.

35. A defeat on the battlefield may be a blessing.

36. Hardships are not infrequently a blessing in disguise.

37. Full many a rose is born to blush unseen.
38. In economic phenomena that which is not seen is often better worth studying than that which is seen.
39. Honest work is rarely unrewarded.
40. Men of violent minds are not all lacking in tenderness.
41. Not all obscure books are profound.
42. Few people can describe adequately what they see.
43. One gas at least cannot yet be liquefied.
44. One always has generous intentions when one is poor.
45. Sometimes labour is efficient even when it is cheap.
46. Very few are just to those whom they dislike.
47. Out of sight out of mind.
48. Not all people who are not discontented are unambitious.
49. Sometimes a joke is worth ten arguments.
50. In our management of other people fun will often succeed when bullying won't.
51. The measure of a man's value are his ideals.
52. Nothing venture, nothing have.
53. There is some soul of goodness in things evil.
54. Few people realize their own shortcomings.
55. Who ever loved that loved not at first sight ?
56. Many people have excellent morals, but odious ways.
57. Not all who have suffered from oppression have learned the lesson of not oppressing others.
58. It is a poor consolation that is obtained by shutting the eyes to facts.

EXERCISES IN IMMEDIATE INFERENCE 27

59. It is sometimes easier to do what is heroic than to do what is only right.

60. It is impossible to understand thoroughly what we do not love.

61. Bad news and good advice are never well received.

62. All the good intentions in the world cannot undo the evils caused by ignorance.

63. It takes two to quarrel.

64. Waste not, want not.

65. Faint heart never won fair lady.

66. All the perfumes of Arabia will not sweeten this little hand.

67. No news is good news.

68. Where there is smoke there is fire.

69. Wise men ne'er bewail their woes.

70. A stitch in time saves nine.

71. It is much more difficult to form one's own judgment than to receive it from others.

72. Normal action is not always right.

73. Hardly anyone believes in the glory of war who has seen its devastation.

74. Where ignorance is bliss it is folly to be wise.

75. Few people succeed who only think of their success.

76. Laugh, and the world laughs with you ; weep, and you weep alone.

77. He can't be wrong whose life is in the right.

78. Clever men are as common as blackberries ; the difficulty is to find a good one.

79. All desire the good ; but few will pay the price.

80. Things noble are as difficult as they are rare.

81. Explain the logical relation between the two statements in each of the following pairs :—

(a) People always blame others for their own failure. Some who fail do not blame others for it.

(b) Few of those who had worked failed. Not all who failed were idlers.

(c) To be an expert one must have wide experience. One is either experienced or no expert.

(d) Diamonds are always white. Some diamonds are yellow.

82. Explain the logical relation between the two statements in each of the following pairs :—

(a) All succeed who work. Some workers fail.

(b) What is sauce for goose is sauce for gander. What is sauce for gander is sauce for goose.

(c) The candidates are all graduates. There is no undergraduate among the candidates.

(d) To be popular one must be considerate. One is either considerate or not popular.

83. Express the following statements in logical form and explain their mutual relations :—

(a) No one can be happy unless he is prudent.

(b) Prudent people are never unhappy.

(c) Most unhappy people are imprudent.

(d) Few prudent people are unhappy.

84. Show that, if it is false that "no treaties can prevent war," it must be true that "war is preventable"; but if it is true that "all treaties fail to prevent war," it does *not* follow that "war is unpreventable."

85. Classify the subjoined assertions into the following four groups: (i) Those which can be inferred from (*a*); (ii) those from which (*a*) can be inferred; (iii) those which are incompatible with (*a*); and (iv) those which are consistent with (*a*) but cannot be inferred from it.

- (*a*) All just acts are expedient.
- (*b*) No expedient acts are unjust.
- (*c*) No just acts are inexpedient.
- (*d*) All inexpedient acts are unjust.
- (*e*) Some unjust acts are inexpedient.
- (*f*) No expedient acts are just.
- (*g*) Some inexpedient acts are unjust.
- (*h*) All expedient acts are just.
- (*i*) No inexpedient acts are unjust.
- (*j*) All unjust acts are inexpedient.
- (*k*) Some inexpedient acts are just acts.
- (*l*) Some expedient acts are just.
- (*m*) Some just acts are expedient.
- (*n*) Some unjust acts are expedient.

86. Classify the following propositions as in question 85 :—

- (*a*) Some beliefs that are not true are useful.
- (*b*) Some beliefs that are not useful are true.
- (*c*) Some mistaken beliefs are useless.
- (*d*) No useless beliefs are other than erroneous.
- (*e*) All beliefs that are not true are not useful.
- (*f*) All true beliefs are useful.
- (*g*) All useful beliefs are true.
- (*h*) No useful beliefs are true.
- (*i*) No true beliefs are useless.
- (*j*) No useful beliefs are false.

(k) All useless beliefs are false.

87. Classify the following propositions as in question 85 :—

(a) No Members of Convocation are other than Graduates.

(b) No Graduates are not Members of Convocation.

(c) All who are not Graduates are not Members of Convocation.

(d) Some who are not Members of Convocation are Graduates.

(e) Some who are not Members of Convocation are non-Graduates.

(f) All Members of Convocation are Graduates.

(g) All Graduates are Members of Convocation.

88. Classify the following propositions as in 85 :—

(a) No successful people are incapable.

(b) All successful people are capable.

(c) Some unsuccessful people are capable.

(d) Some capable people are unsuccessful.

(e) Some capable people are not successful.

(f) All capable people are successful.

(g) No capable people are successful.

(h) Some incapable people are successful.

89. Comment on the logical character of the following argument : Freedom of speech is of the essence of democracy. To renounce freedom of speech is to renounce democracy.

90. X would rather be good than bad, but he would rather be rich than good. What conclusion can be drawn ?

GROUP G

THEORY OF INFERENCE

1. Explain the meaning of the terms *immediate inference*, *mediate inference*, *deductive inference*, *sylllogism*, and their mutual relations.

2.* Explain the view that inference is a kind of mental construction, and compare it with other kinds of mental construction. How is inference related to apodictic judgment ?

3.* Explain and discuss the view that the fundamental principle of inference is implication.

4.* How is inference related to judgment, and what is meant when inference is described as consisting essentially in the self-development of a subject ?

5.* Explain the view that all inference involves reference to a universal ; and examine its accuracy with special reference to inference from circumstantial evidence.

6.* Describe the function of analysis and synthesis in judgment and inference, and comment on the view that " analysis and synthesis have so much in common that they are actually identical."

7.* Examine the view that Mill's doctrine of

inference from particulars to particulars is the logical outcome of his Nominalism.

8.* Discuss the dictum that "abstraction is reasoning."

9.* "In the end all judgment is irremediably conditional." Examine this view and its bearing on the relation between judgment and inference.

10.* Explain *argumentum a fortiori*, and give examples of its correct and incorrect use.

GROUP H

SYLLOGISTIC DOCTRINE

1. Give a general account of the nature of the syllogism.

2. Explain on the most general grounds why no conclusion can be drawn (*a*) when both premises are negative, (*b*) when the middle term is not distributed.

3. When the minor premise of a syllogism is negative the major premise must be universal. Why?

4. When the conclusion is universal the middle term cannot be distributed twice. Why?

5. Consider under what circumstances it is possible to draw a valid conclusion from (*a*) two particular premises, (*b*) two negative premises.

6. To what extent can an O premise be used in each of the four figures?

7. Which of the following moods are invalid (*a*) in every figure, (*b*) in any figure—IEO, AAA, IAI, OAO, EAE, AOO?

8. Discuss under what circumstances it is possible to draw an accurate conclusion (*a*) by affirming the consequent of a hypothetical proposition, (*b*) by affirming an alternative of a disjunctive proposition.

9. Explain the nature and value of the process of rebutting a dilemma.

10. Can an O proposition occur in a Sorites either as premise or as conclusion? Justify your answer.

11. Can the syllogism be regarded as arguing from certain cases to other cases like them?

12. In Geometry one draws a diagram and proves the theorem with reference to that diagram. Is that reasoning from particulars?

13. Explain and examine Mill's view that in every syllogism there is a *petitio principii*.

14. Consider the statement that Mill's account of the syllogism suffers from his failure to recognize the true nature of universals.

15. Is the syllogism the only type of deductive inference?

16. Give two valid syllogisms, which contain an identical premise and have contrary conclusions, write down the syllogisms, determining their moods and figures.

17.* Show by means of an example that a syllogistic conclusion from certain premises can also be inferred from the contraries of those premises. What can you prove about the general character of such a syllogism? Does the possibility of drawing the same inference from pairs of contrary premises throw any doubt on the validity of syllogistic inference? State your reasons.

18.* Can a syllogism prove one of its own premises, or disprove its own conclusion? If not, how would you show that the following examples do not do so?

- (i) Some purely empirical inductions are proved syllogistically.

All purely empirical inductions are particular conclusions.

∴ Some particular conclusions are proved syllogistically.

- (ii) All genuine inference is from the known to the unknown.

Syllogism is not from the known to the unknown.

∴ Syllogism is not genuine inference.

19.* Discuss the real character and value of syllogistic inference, and consider the significance of the criticism that "the so-called premises by themselves never are all that is really required for the conclusion."

20.* Consider the logical significance of the fact that valid deductions from true premises are sometimes confuted by the facts.

GROUP I

SYLLOGISTIC EXERCISES

RESTATE the following arguments in such a way as to display clearly their logical structure, supplying (in brackets) any propositions which may be implied but not stated. In each syllogism state the major premise first, and the conclusion last; and make its Figure and Mood clear by expressing it also symbolically.

Thus :	MeP	If S is M, P is Q
	SaM	P is not Q
	∴ SeP,	∴ S is not M,

and so on. If any argument is considered invalid, name the fallacy, and explain what syllogistic rule it violates.

1. Common sense is something of which all men have an ample measure. Everybody thinks himself abundantly provided with it: even those who are most difficult to satisfy in everything else do not desire more common sense than they already have. Nor is it likely that all are mistaken: the universality of the conviction is rather to be held as testifying to its truth.

2. Mr. X maintains that every person should

regard it as his highest duty to undergo military training and service for his country. But since he does not advocate such military training and service for women, he evidently does not regard a woman as a "person."

3. If then, as is generally allowed, the virtues are voluntary, it follows that our vices too must be voluntary, as what is true of one is equally true of the other.

4. The radical is not always unselfish ; your mere malcontent, for example, is often rather a selfish being, and every malcontent is, of course, a radical.

5. Emperors may be good men, and good men may be Emperors, for Marcus Aurelius was both a good man and an Emperor.

6. Without slavery of some kind there can be no civilization. For there can be no civilization without leisure ; and slavery makes leisure possible.

7. All metals, it is true, are conductors of electricity ; but then the atmosphere is not a metal, and therefore cannot be a conductor of electricity.

8. Some fortunate people do not appreciate their good fortune, simply because people will not appreciate what they acquire without toil.

9. The rings of Saturn must be material bodies, for they are visible, and only material bodies are visible.

10. The fixed stars must be subject to the law of gravitation, because they are material bodies, and no material body is not subject to the law of gravitation.

11. Only ten-pound householders have votes,

but as Smith is a ten-pound householder he must have a vote.

12. X must be a Catholic, for he is an Italian, and Italy is a Catholic country.

13. Most of the electors were in favour of female suffrage, and most of them were conservatives. Therefore some conservatives were in favour of female suffrage.

14. X is not a loyal member of his party, for he criticizes the policy of his party.

15. Self-centred people never achieve anything great, because they cannot co-operate with others.

16. People never learn anything about beauty because they start with the idea that they know all about it.

17. Mr. B's new play is popular because it is romantic and has a happy ending.

18. Prof. Oracle is not a good teacher. He treats his students as if they were mere buckets to be pumped into.

19. Macaulay, Mommsen, and Treitschke project their own broad shadows upon their pages. But historians are seen at their best when they do not appear.

20. It is precisely because we believe that opinion can effect great permanent changes, that we ought to be careful to keep this most potent force honest, wholesome, fearless, and independent.

21. " ' You are a philosopher, Dr. Johnson,' said Edwards. ' I have tried, too, in my time to be a philosopher ; but I don't know how ; cheerfulness was always breaking in.' "

22. Since some coarse and cheap practitioners earn a great income and enjoy abounding popularity, the man of genius is demeaned when he catches the ear of the multitude.

23. Valuable things do not always count as wealth, for some of our most valuable possessions have no exchange value.

24. Whosoever loveth wine shall not be trusted of any man, for he cannot keep a secret.

25. The line A B is equal to the line C D, for they are radii of the same circle.

26. Wind and weather are unpredictable although they are governed by laws.

27. Knowledge is foresight, and foresight is power.

28. No secret trial is expedient ; for it invariably casts a suspicion on the integrity of the judges.

29. Animals are agreeable companions—they ask no questions and pass no criticisms.

30. Interesting work is play, and play is life.

31. Some people are incapable of making anybody happy, simply because they have no capacity for enjoyment.

32. Certain authors are popular merely because they express views about which commonplace people can say : “ That is just what I always thought.”

33. If we really want a thing we look out for it with special keenness. That is why we detect it sooner than do others who do not specially want it.

34. Wishes are not horses, else beggars would ride.

35. If all people were clever, there would be no need for examinations.

36. Life would not be so interesting if we could see the future clearly, for then we should lose much of the pleasure of hope.

37. If ye only love them that love you, what merit have ye? Do not even the publicans do the same?

38. If the *Anatomical Engravings* of Eustachius had been published when they were made (16th cent.), the study of anatomy would have been advanced by two centuries.

39. Comedy is possible only in a civilized country; for in a comparatively barbarous one the people cannot bear to have their follies ridiculed.

40. Alchemists believed that most of those who lived before the Flood had a knowledge of "the philosopher's stone." How else could Methuselah and others have lived so long?

41. Darwin must have been very unhappy. For he said that he would feel very happy if he had only to observe and not to write; and we know, of course, that he wrote many books.

42. Free Trade must bring prosperity; for England is the richest country in the world; and this is just what you would expect if Free Trade brought prosperity.

43. If all the absurd theories of lawyers and divines were to vitiate the objects in which they are conversant, we should have no law and no religion left in the world.

44. If the law were really impartial and punished blasphemy because it offends the feelings of believers, then it ought also to punish such preaching as offends

the feelings of unbelievers. But the law imposes no restraints on the believer, however offensive his teaching may be to those who do not agree with him.

45. Reserve is restraint, and restraint is painful, and pain is intolerable to the self-indulgent.

46. The uncritical acceptance of the views of one's teachers is no real education. It fails to develop the power of independent judgment, which is the essence of real education. *

47. Devout people are not necessarily moral people. Henry III of France, e.g., was a notorious seeker after forbidden things, yet he was devout, ordering prayers for the success of projected murders, and attending mass during their commission.

48. Indiscriminate unemployment doles tend to raise the cost of living. For they cause a shortage of labour, which keeps wages high, and so raises the price of commodities.

49. Examiners who are excessively tender with weak candidates are unjust towards the better candidates. For they reduce the standard of the examination, and therefore the value of passing it, even for those who have reached the higher standard.

50. The struggle for existence is often beneficial in its results. For it makes the mind more alert, and improves moral character. And an alert mind and a good character make life interesting and fruitful.

51. Free Trade is a great boon to the working man; for it increases trade, and this cheapens articles of ordinary consumption; this gives a

greater purchasing power to money, which is equivalent to a rise in real wages, and any rise in real wages is a boon to the working man.

52. The knowledge of several languages is of great educational value. For it shows us that the same word may represent different ideas, and that the same idea may be expressed by different words, and so helps us to discriminate between words and ideas, which is an indispensable condition of clear thinking.

53. Without discipline the highest life is unattainable. For he who has never learned obedience can never become his own master, and whosoever is not master of himself through all his life lacks that mental balance and sanity without which an harmonious life is impossible.

54. When a new work by one of the greatest of living composers—and he an Englishman and a Londoner—is given, out of London's seven millions there cannot be found enough music-lovers to fill a small hall. Evidently what is lacking in our public is not enthusiasm but curiosity. The lack of curiosity comes from lack of knowledge. And the lack of knowledge is due to the ignorant handling of music in the newspapers by editors and "subs." who, not being musical themselves, have no idea how interesting music is to thousands of their readers.

55. A favourable state of the exchanges will lead to importation of gold; this will cause a corresponding issue of bank-notes which will occasion an advance in prices; which again will check exportation and encourage importation, tending to turn the exchanges against us.

56. The happiness of the community depends on its wealth ; the wealth of the nation depends on maintaining and increasing its annual product ; the best way of doing this is by letting each citizen make himself as rich as he can in his own way ; the quickest way to personal riches is profit-making in a free market ; hence unrestricted profit-making by individual capitalists is the best way of securing the welfare and happiness of the nation.

57. High taxation and unemployment provide a vicious circle. High taxation reduces the amount of money available for business enterprise, and so leads to unemployment. Unemployment costs the Government £100,000,000 a year, and consequently causes high taxation.

58. Without colonies we have no guarantee regarding raw materials ; without raw materials there can be no industry ; and without industry there can be no prosperity. We must therefore have colonies.

59. Has any small island ever had so momentous a history as Heligoland ? But for it there would have been no German Navy. But for the German Navy there would have been no Great War. But for the Great War the fate of many millions of men and women would have been very different.

60. Unless the juridical equality of all nations is made a fundamental principle of the League of Nations the peace of the world will remain a dream. For without such equality there will be a sense of injustice. This means discontent, and discontent does not make for peace.

61. Without a large proportion of poverty, there could be no riches, since riches are the offspring of labour, while labour can result only from a state of poverty. Poverty is that state and condition of society where the individual has no surplus labour in store, or, in other words, no property or means of subsistence, but what is derived from the constant exercise of industry. Poverty is therefore a most necessary and indispensable ingredient in society, without which nations and communities could not exist in a state of civilization.

62. Freedom of speech is one of the conditions of the progress of civilization. For the progress of civilization depends on our deliberate adaptation of our habits and institutions to changing conditions. But such adaptation requires the correction of old errors and the acquisition of new knowledge. And these are only possible when there is complete freedom of speech.

63. The average man regards new ideas as an evil. For the due consideration of new ideas inconsistent with his previous beliefs requires a mental rearrangement—which is a laborious process. But the average man is intellectually lazy, and condemns as an evil whatever he finds disagreeable.

64. The best way to make friends is to appear to be interested in them; the best way to appear to be interested is to be really interested in them; and to be interested in others one must cease to be self-centred.

65. Without strength there is no courage, without

courage no manliness, and without manliness no originality, except in the invention of new forms of scoundrelism.

66. This author is certainly confused. If I understand his book rightly, he is confused in his thinking, and if I do not understand it, then he is confused in his writing.

67. Everybody is pleased with *Abraham Lincoln*. The jingoes like the play because of its fighting patriotism; the others like it because of its broad humanitarianism.

68. Film operas are a failure. If you watch the pictures you are disturbed by the music which does not synchronize with their action; and if you listen to the music you are distracted by the pictures which do not synchronize with it.

69. How can Protection accomplish *all* that is claimed for it? If it increases the revenue, how can it also stimulate home industry? And if it stimulates home industries, how can it increase the revenue?

70. Compulsory attendance at College Chapel is absurd; for, if the undergraduates care about religion, they will attend without compulsion; and if they attend only because they are compelled, their attendance is worthless.

71. Referring to the evidence of Barrett, the judge remarked that he was the witness who said he was assisted by the solicitor for the defence, while the solicitor had said that this was untrue. Now, if Barrett was not speaking the truth in regard to that incident, they could not rely on any of his

evidence. But if he was speaking the truth, what was the value of his evidence if he had to be prompted by the solicitor ?

72. The attempt to raise the wages of coal-miners by legislation is ill-advised. For the law is sure to fail if economic conditions are unfavourable, while if economic conditions are favourable no legislation is necessary.

73. Light is seen on portions of the moon which are not directly illuminated by the sun. This light must be due to the moon's own light, or to light reflected from the earth. But certain phenomena connected with eclipses show that the moon is not self-luminous. The light in question must consequently be due to reflected earth-light.

74. Why fear death ? To fear death is to fear either being deprived of all feeling or being subjected to some other kind of feeling. But if we are deprived of all feeling we shall have no evil to fear ; if we are to find new kinds of sensations our existence will indeed be different, but still we shall continue to exist.

75. I am walking with a friend in the garden, and we see a moth alight upon a flower. He exclaims : " What a beautiful butterfly ! " Whereupon I remarked : " That is not a butterfly ; it is a moth." If he asks me how I know that, the answer is : " Because butterflies, when they alight, close their wings vertically ; moths expand them horizontally."

76. The animals used in cancer research are principally mice. Cancer is one of the most painful

diseases ; yet we are told that the mice in which cancerous growths are planted in order to study the disease suffer no pain, although they die of it. But, surely, if the disease of which these mice die really is cancer, then it must go through all the stages, including the painful stage. While if the mice experience no pain in dying of it, they must be so unlike human beings as to render experiments upon them useless, even if they are not cruel.

77. Power pleases the violent and proud, wealth delights the placid and timorous ; youth, therefore, flies at the power, and age grovels after the riches.

78. Dogmatic teaching does not make thinking pupils, for it does not encourage independent thinking.

79. People accustomed to despotic rule find self-government very difficult when they attain to freedom, because they have not had sufficient opportunity for the exercise and development of their powers.

80. The Majority Report of the Divorce Commission is a dangerous document. For it recommends an increase in facilities for divorce. This would have the effect of loosening the marriage bond, and so weaken family life, on which the stability of the State depends.

81. The absence of complete candour from theological discussions is justifiable. For it is a kind of compromise. Now no one disputes the necessity of compromise in politics. Why, then, should one question in the intellectual domain what is so convenient, even necessary, in the political domain ?

82. Excessive discipline makes one weak-willed. For undue subordination to others leaves one insufficient opportunity for the exercise and development of one's own will.

83. No perfectly wise men are seekers after wisdom, for they do not need to seek for that which they already have. And the utterly ignorant and foolish do not seek wisdom, for they do not feel the want of it. Thus the philosopher must be a mean betwixt the two.

84. The printers to the Bank of England claimed exemption from military service for some expert casters in their stereotyping department. It was urged that without them it would not be possible to go on with the printing of dividend warrants, and if there are no dividend warrants there will be no dividends, and if there are no dividends there will be no more loans, and if there are no loans there will be no munitions.

85. Trade bursts local barriers, because industry is the history of invention responding to the pressure of wants, and because a locality cannot get the use of inventions unless it shares them with other localities.

86. The Helvetii, if they went through the country of the Sequani, were sure to meet with various difficulties; and if they went through the Roman province, they were exposed to the danger of opposition from Cæsar; but they were obliged to go one way or the other; therefore they were either sure of meeting with various difficulties or exposed to the danger of opposition from Cæsar.

87. Tariff-reformers will be pleased in any case ; for they will be pleased if their policy becomes law, and if it does not they will still be pleased because they will continue to buy things more cheaply than they could under Tariff Reform.

88. If God exists, He is perfect : if He is perfect, He is wise, almighty, and just ; if He is just and almighty, my soul is immortal ; if my soul is immortal, thirty years of life are nothing to me, and these years, with all that happens in them, may be necessary for the maintenance of the universe.

89. The consumers' interest is not the conscious side of invention ; but it is only through the consumers' interest that the inventor gets his profit.

90. To have wants is to have hopes, and to have hopes is to be in the way of progress. Lassalle was therefore right in speaking of the " accursed absence of wants " among the poor.

91. Mr. X will have to change his views if he wants to be in Parliament. For the Liberals will not have him unless he changes his views on the House of Lords ; and the Conservatives will reject him unless he changes his views on Free Trade.

92. For Canada to build one or two warships in order to protect her coast would be sheer waste of money. For, except the United States, no Power could evade or overcome the British Navy ; whilst if the United States resolved to invade Canada no navy in the world could prevent it.

93. Our violent English games are a splendid training in self-control. For they teach boys to

suffer pain with no resentment against those who cause it.

94. The peasant-state presents a condition of imperfectly developed social intelligence. For it is a form of society in which there is no differentiation—its structure repeats itself from household to household. And where there are no specialized functions, there intelligence cannot be fully developed.

95. Sir Ernest said that lots of prominent lawyers made observations without any object. Sir John retorted that he had been making observations with a definite object. Thereupon Mr. Justice Darling concluded that Sir John could not be a prominent lawyer.

96. No honest lawyer will plead for an accused person. For the accused is either guilty or innocent. If he is guilty he ought not to be defended ; and if he is innocent it must be apparent to his judges.

97. If the judges are not respected, neither will the law be. It is therefore the duty of judges to be on their guard.

98. Apollo behaved badly towards Orestes. For if it was wrong for Orestes to kill his mother, then Apollo should not have commanded him to do so ; and if it was right, then he should have protected him from the Furies.

99. Political freedom is indispensable for a people's cultural development. For despotism lowers the nation's self-respect and checks enterprise in its most important sphere, the management

of the commonwealth; and what is hostile to enterprise and self-respect is hostile to science and art.

100. The French Government tends to reduce the cost of living because it is so much more democratic, and in a democratic country some of the most important items of domestic expenditure are necessarily reduced. For instance, in France public education is practically free among all classes. The French people have not the "caste" system which prevails in the public schools of England, and the son of a millionaire sits on the same bench with the son of the shoemaker. And because even higher education costs nothing, the liberal professions are accessible to every class. And because they are accessible, there is much keener competition. And because there is keener competition, the fees of the French lawyer and the French doctor are one-fifth and sometimes one-tenth, of what they are in this country. A distinguished specialist and University professor, who in England would charge from one to three guineas to a consulting patient, in France and Belgium charges from 2s. 6d. to 4s.

GROUP J

THEORY OF INDUCTION

1. Explain the terms *science* and *scientific attitude*.
2. Distinguish between (a) the *technical* and (b) the *logical* methods of science.

3. "Inductive Logic must be as formal as any other." Discuss this.

4. What is meant by the statement that Induction is *inverse* Deduction ?

What is an inverse process, and why does it generally involve an element of uncertainty ?

5. Explain the distinction between *a priori* and *a posteriori* reasoning.

How is it related to the distinction between deductive and inductive inference ?

6. Discuss the meaning of the Principle of Uniformity of Nature and the possibility of proving it inductively.

"The course of nature in truth is not only uniform, it is also infinitely various." Does the latter fact occasion any difficulty in respect to the former ?

7. Explain the principle of universal causation.

8. Distinguish between Symptom, Condition, Cause, Reason.

9. Distinguish between the *complexity* and the *plurality* of causes.

10. "The difference between observation and experiment is one of degree and not of kind." Discuss this, point out the advantages of experiment as compared with observation, and comment on the use of instruments of observation.

11. What is the difference between *non-observation* and *mal-observation* ?

12. Can non-observation ever be regarded as evidence of the non-existence of a thing, or the non-occurrence of an event ? Discuss the following defence :—

A man who was accused of theft on the evidence of two witnesses offered to bring in his defence ten witnesses who had not seen him commit a theft.

13. Explain the function of hypothesis in scientific investigation, and comment on the dictum :—

"The formation of an hypothesis is a concrete expression of the tendency to explain things by general principles characteristic of thought throughout."

14. Comment on the statement, "No theorizing apart from observation, and no observing save in the light of theory."

15. What is meant by the Verification of an Hypothesis ?

16. Consider the relation of Causality to Law ; and discuss the view that the business of science is to study the correlations of phenomena, not their causal connections.

17. Illustrate the way in which hypotheses are suggested through attention paid to analogies.

18. Which of the inductive methods can be employed in an investigation which is confined to positive instances only? Describe and illustrate them.

19. Describe carefully the Method of Difference, and compare it with the Method of Concomitant Variations.

Can you indicate the chief practical difficulty attending the employment of these methods?

20. "Considering how much in every experiment is assumed as already known . . . the wonder is that no one has insisted upon regarding every method [of induction] as concerned with residues." Explain.

21. What is meant by an *experimentum crucis*? Give an instance.

22. Explain and illustrate the statement *exceptio probat regulam*.

23. Discuss the logical character of inference by analogy. Is it adequately described as an argument from one particular to another?

24. What constitutes a Scientific Explanation? Comment on the following views:—

(a) "Explanation describes the unknown and unfamiliar as being made up of the known and the familiar."

(b) "The proneness to substitute familiarization for radical explanation is the besetting sin of human understanding."

25. Is there any distinction, and if so what, between a complete Description and an Explanation?

26. Can Explanation be identified either with induction or with deduction? Is there any real distinction between the explanation of a law and the explanation of a fact?

27. Explain and illustrate the so-called Historical Method.

28. Compare the so-called Geometrical Method with the Physical Method.

29. What is the nature of the evidence usually relied upon in criminal investigations? Show how the reasoning that is based upon it is related to other kinds of reasoning.

30. Describe and illustrate the method in use when the phenomena under investigation are regarded as the product of gradual evolution.

31. Describe the chief uses of Statistical Methods, and explain the terms *average*, *error*, *correlation*.

32. How would you test the suggestion that orphan asylums and similar institutions tend to disqualify their inmates for decent family and civic life? Justify your view.

33. What principles are involved in (a) the inductive establishment, and (b) the deductive application of statistical regularities?

34. Explain the logical ground for judging a group, or a class, by means of a sample.

35. Describe and illustrate the Comparative Method.

36. Discuss the contention that Mill's so-called Inductive Methods "are not *inductive* at all, in the sense of generalizing from particulars."

37. Consider the assertion that "causality is

concerned directly with relations between single events, and only derivatively with causal laws."

38. Discuss the view that our faith in well-established inductions cannot be justified by any known principle of probability unless some further premise about the physical world be assumed.

39. Explain and illustrate the different ways in which deductive and inductive reasoning are sometimes combined in the solution of scientific problems.

40. Consider the contention that science is concerned only with description, not with explanation.

41. Explain and illustrate the various kinds of hypotheses, and discuss the chief considerations which influence one's choice between rival hypotheses.

42.* "It assumed that if we are asked why we believe that the sun will rise to-morrow, we shall naturally answer, 'Because it has risen every day.' But I should say that a better answer would be 'Why not?' " Examine the different conceptions of the ground of inductive inference implied in the different answers.

43.* Give a critical account of the relation of induction to the calculus of probability.

44.* Compare the method of simple enumeration with the statistical method and with the method of agreement.

45.* The sciences, it is usually maintained, aim at the discovery of laws. Are the laws formulated in the various sciences all of the same type? Give reasons for your answer.

GROUP K

EXERCISES IN SCIENTIFIC METHOD

IN the following passages various investigations are summarized very briefly. Just enough is given in each passage to indicate the general character of the procedure and of the methods employed. What is required is a description of this procedure and of these methods in the light of the logic of induction, or the study of scientific method. The general mode of treatment to be followed in the analysis of these passages is, perhaps, best indicated in the following list of questions, remembering always that not all the considerations here enumerated will be called for in all cases.

- (a) What is the *problem* considered in the passage ?
- (b) What *hypothesis*, or hypotheses, does it propound ?
- (c) What *evidence* is adduced *pro* or *con* ?
- (d) What *method*, or methods, does the evidence follow ?
- (e) Is there adequate *verification* ?
- (f) What *fallacy* is committed or imputed ?

1. Lightning travels in a zigzag line, and so does an electric spark ; electricity sets things on fire, so does lightning ; electricity melts metal, so does

lightning. Animals can be killed by both, and both cause blindness. Electricity always finds its way along the best conductor, or the substance which carries it most easily, so does lightning; pointed bodies attract the electric spark, and in the same way lightning strikes spires and trees and mountain-tops. Is it not most likely that lightning is electricity passing from one cloud to another, just as an electric spark passes from one substance to another?

If lightning is electricity, it must be possible, with the proper equipment, to draw this electricity to the earth. Accordingly, a kite was sent up during a thunderstorm, and a connection was thus established between the clouds and the earth. To the end of the string by which the kite was held there was tied a metal key. The string was then lengthened with some silk. Since silk is a bad conductor of electricity, the electricity would be collected in the key, instead of escaping through the hand that held the silk. It was then found that if the key was touched with the finger, the usual effects of contact with electricity resulted.

2. If the lungs be emptied as perfectly as possible and a handful of cotton-wool be placed against the mouth and nostrils, and you inhale through it, it will be found on expiring this air through a glass tube that it is free from floating matter.

3. How indispensable Secretary Oldenburg was to the Royal Society may be gathered from the fact that during his long imprisonment in the Tower of London the Society did not hold any of its usual meetings.

4. When air is confined with moistened iron filings in a closed vessel over water, the iron filings rust, and the volume of air is diminished. Moreover, the air which remains does not support flame or life. This shows that the iron absorbs part of the air, and indeed that part of the air which supports fire and life.

5. Observations made in a variety of cases have shown that whenever ether is administered to a patient he breathes more deeply than before. It may, therefore, be concluded that ether causes deep breathing.

6. It was a general belief at St. Kilda that the arrival of a ship gave all the inhabitants colds. Dr. C. took pains to ascertain the fact and to explain it as the effect of effluvia arising from human bodies; it was discovered, however, that the situation of St. Kilda renders a north-east wind absolutely necessary before a ship can make the landing.

7. Pliny rejected the belief in nativities (i.e. the determination of a man's destiny by the star under which he was born) on the ground that masters and slaves, kings and beggars are frequently born at the same time.

8. The length of the string determines the pitch of the note, for it is inversely proportional to the length of the vibrating string.

9. It has been observed that the simpler the type of an animal's nervous system the fewer and more mechanical are the activities of which the animal is capable; while, on the other hand, the more

elaborate the nervous system the more complex and adaptable are its reactions. And, since intelligence generally shows itself by great adaptability to surroundings, it would appear that intelligence depends on the nervous system.

10. Heat was once regarded as an imponderable substance which was absorbed by bodies when they were warmed, and was given out as they cooled. Rumford and Davy showed that the quantity of heat which two portions of the same body could be made to give out, by rubbing them together, was practically illimitable. The above view of heat had therefore to be abandoned, for how could a finite body contain an infinite quantity of another body? In 1843 experimental proof was given of the fact that there is a definite relation between mechanical work and heat; that so much work always gives rise to so much heat. Thus originated the mechanical theory of heat.

11. The effect of green feed on the colour of the yolks of eggs has been studied recently by Prof. Wheeler of New York. Four lots of hens were fed alike, except that no hay or green feed was given to one lot, while the other three lots had varying amounts of clover hay alternating with green alfalfa. The depth of colour of the yolk varied in the different lots, and, roughly speaking, was directly proportional to the amount of the clover and alfalfa on which the laying hens were fed. Apparently the colouring matter present in the green feed affects the yellow colouring matter of the yolks of eggs.

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12. How little the individuality of cabinet ministers counts, is shown by the fact that the country is governed in the same sort of way in spite of repeated changes in the cabinet.

13. A scientist placed a number of sapphires of different kinds in a box containing a minute quantity of radium. A month later the white sapphires had become yellow; the blue sapphires, green; the wine-coloured sapphires, red; and the dark blue sapphires, blue.

14. Why is it that children are often bright and interesting, while grown-ups are dull and uninteresting? What has happened in the interval? The answer is Education.

15. Some who have been imprisoned for blasphemy have really been punished for their ignorance. For they only uttered in language of deplorable taste views that are expressed politely in books which are in the libraries of Bishops, and against which the law was not enforced. Thus the law in regard to blasphemy simply penalizes *uneducated* free-thinkers.

16. When we put any limb in motion the seat of the exertion appears to be in the limb, whereas it is demonstrably no such thing, but either in the brain or in the spinal marrow; the proof of which is, that if a little fibre, called a nerve, which forms a communication between the limb and the brain, or spine, be divided in any part of its course, however we may make the effort, the limb will not move.

17. Wort, when it is prepared and stored in such

a way that no dust can enter it, remains uncontaminated indefinitely. But when it is exposed to the air under conditions which allow it to gather the dusty particles which float in the atmosphere, then it deteriorates.

18. To-day a certain peculiar type of climate prevails wherever civilization is high. In the past the same type of climate seems to have prevailed wherever a great civilization arose. Therefore such a climate seems to be a necessary condition of great progress. It is not the only, or the most important condition; but it is one of the conditions.

19. Poulton and Sanders experimented with 600 pupæ of the tortoise-shell butterfly, in order to test the theory of protective coloration. The pupæ were artificially attached to nettles, tree-trunks, fences, walls, and to the ground, some at Oxford, some at St. Helens in the Isle of Wight. In the course of a month 93 per cent. of the pupæ at Oxford were killed, chiefly by small birds, while at St. Helens 68 per cent. perished. At Oxford only four pupæ, fastened to nettles, emerged; all the rest perished. At St. Helens the eliminations were as follows: on fences, where the pupæ were conspicuous, 92 per cent.; on bark, 66 per cent.; on walls, 54 per cent.; and among nettles, 57 per cent. The experiments showed very clearly that the colour and character of the surface on which the pupa rests—and thus its own conspicuousness—are of the greatest importance.

20. Dorfmeister has shown that the same chrysalis,

according as it was submitted to cold or heat, gave rise to very different butterflies, which had long been regarded as independent species, *Vanessa levana*, and *V. prorsa*; an intermediate temperature produces an intermediate form.

21. The size of rivers is found to vary with the size of the towns through which they flow, and must therefore depend on these.

22. As we leave Yorkshire and approach Durham and Northumberland the Norse names rapidly diminish in frequency, and north of the Tweed they entirely disappear. The names of a few bays and headlands prove that the Northmen were familiar with the navigation of the coast, while the absence of any Norse names of villages or farms proves that the soil for some reason was left in the undisturbed possession of the Anglians or Celts.

23. M. Arago, having suspended a magnetic needle by a silk thread, and set it in vibration, observed that it came much sooner to a state of rest when suspended over a plate of copper than when no such plate was under it. Now in both cases there were *veræ causæ* why the needle should come at length to rest, namely, the resistance of the air and the want of perfect mobility in the silk thread. But the effect of those influences being exactly known by the observation made in the absence of the copper, and being allowed for, it was concluded that a retarding influence was exerted by the copper itself.

24. Years ago porters might be seen at the street corners in Edinburgh, wearing over their shoulders

long straps which they did not use. Why did they wear them? The straps were a relic of the days the Sedan-chair. They were used formerly to support the poles of Sedan-chairs. As a matter of habit porters continued to carry the straps when they ceased to be of use.

25. It may be presumed that all animals which feed on various substances possess the sense of taste, and this is certainly the case with worms. Cabbage-leaves are much liked by worms; and it appears they can distinguish between different varieties; but this may perhaps be owing to differences in their texture. . . . Pieces of the leaves of cabbage, turnip, horse-radish, and onion were left on the pots during 22 days, and were all attacked and had to be renewed, but during the whole of this time leaves of an *Artemisia*, and of the culinary sage, thyme, and mint, mingled with the above leaves, were quite neglected, excepting those of the mint, which were occasionally and very slightly nibbled. These latter four kinds of leaves do not differ in texture (from the others) in a manner which could make them disagreeable to worms; they all have a strong taste, but so have the four first-mentioned kinds of leaves; and the wide difference in the result must be attributed to a preference by the worms for one taste over another.

26. Wealth is greatly increased by the change from production on the small to production on a large scale, by the introduction of machinery and the division of labour. This holds equally if we compare a railway with a stage-coach, or a coach

with a pack horse ; a cotton mill with a spinning-wheel, or a spinning-wheel with a distaff and spindle. Under every form, at every stage, and in every period, wealth has been increased by improved and extended co-operation between human beings. This complex co-operation of many-sided individual effort, then, appears as the mainspring of industrial progress. Where it is not we have stagnation—primitive barbarism ; where it is found, in whatever form or degree, there, by one means or another, industry is improved, and the material side of life is made perfect.

27. Goldscheider had his arm suspended in a special frame and moved about by an assistant. His muscles, therefore, had no share in these movements. Yet he could distinguish as small an angle of movement of this arm as when his own muscles moved and supported it. He concluded that muscular sensations play no important rôle in our consciousness of the movements of our limbs.

28. Investigations in Denmark, Japan, Connecticut, Pennsylvania, New York, Maryland, the Carolines, and Georgia show that neither the winter nor the summer is the most favourable season for activity. Both physical and mental activity reach pronounced maxima in the spring and fall, with minima in midwinter and midsummer. The consistency of the results is important. It justifies the belief that in all parts of the world the climate is exercising an important influence on human fitness and its periodical fluctuations.

29. The total eclipse of the sun last week was

observed under perfect conditions from the plateau in Brazil, a few miles from the coast, which was selected by the Greenwich Observatory expedition for their observing station. Dr. Crommelin, who was in charge of the expedition, has cabled to the Astronomer-Royal reporting that he was successful in obtaining photographs of the stars in the Hyades group during the five minutes the sun was hidden by the moon.

When the party returns to England these photographs will be carefully measured, and the positions of the stars shown on them compared with the positions of the same stars on photographs taken at night, when the sun is not in their vicinity, to see if there was any deflection of their light caused by the attraction of the sun as the light rays passed it during the eclipse.

Those who believe light is acted on by gravitation are confident that the eclipse photographs will show that the stars nearest the sun were displaced by nearly two seconds of arc, which Sir Oliver Lodge—who is a doughty opponent of Einstein's theory of relativity, with which these photographs are concerned—has ventured to predict will not be the case.

30. Manufacturing countries, it is said, are always rich, while countries that produce raw material are always poor. Therefore, it is argued, if we would be rich we must have manufactures, and in order to get them we must encourage and help them. But I could make as good an argument to the people of Jamaica, in support of a subsidy to a

theatre. I could say to them: all cities have theatres, and the more theatres it has the larger the city. Look at New York! Philadelphia ranks next to New York in the number and size of its theatres, and that is why it comes next to New York in wealth. I might drop into statistics, and point out that when theatrical representations began in America, its population did not amount to a million, it was totally destitute of railroads, and without a single mile of telegraph wire. Such has been our progress since theatres were introduced that the census of 1880 showed we had more than 50,000,000 people, over 90,000 miles of railroad, and nearly 300,000 miles of telegraph wires.

31. Wine when exposed to air turns into vinegar. Pasteur suggested that the change was produced by a small organism called *mycoderma aceti*. It was well known that this organism was present in the process. But Liebig regarded its presence as a mere coincidence, and that the real cause was the nitrogenous matter present in the wine. In support of his view he adduced the following evidence. If a solution of pure alcohol and water, of the same alcoholic strength as wine, be exposed to the air, even for years, it does not acetify; but if a small quantity of any nitrogenized substance be added to it, it changes into vinegar. Pasteur, however, showed that if to the solution of wine and water there be added, not a nitrogenous substance but a small quantity of saline crystals capable of supporting plant life, then acetification takes place, and the development of the mycoderm can be seen.

32. The old man who has been bathing in the Serpentine every morning for forty years says, "Look at me." I say to him, "Yes, but where are the others?"

33. Cleomides, who lived about the time of the Emperor Augustus, observed that a ring lying at the bottom of an empty vessel and just hidden from view by the side of the vessel became visible when the vessel was filled with water. He thereupon suggested that the sun may already be below the horizon when we still see it at sunset.

34. Sir Charles Lyell, by studying the fact that the river Ganges yearly conveys to the ocean as much earth as would form sixty of the great pyramids of Egypt, was enabled to infer that the ordinary slow causes now in operation upon the earth would account for the immense geological changes that have occurred, without having recourse to the less reasonable theory of sudden catastrophes.

35. The phenomenon of shells found in rocks, at a great height above the sea, has been explained in various ways. Some ascribed it to a plastic virtue in the soil; some to the influence of the heavenly bodies; some to fermentation; some to the passage of pilgrims with their scallops; some to the life and death of real mollusca at the bottom of the sea, and a subsequent alteration of the relative level of the land and sea in that region. Now as regards the plastic virtue of the soil and celestial influence, the very existence of such powers is unknown. Fermentation is a real cause, but it has never been observed to produce shells. Casual

transport by pilgrims is a true cause, and might account for a few shells, but not for so many. On the other hand, it is a usual thing for a shell fish to die at the bottom of the sea and leave its shell in the mud ; and the elevation of the bottom of the sea to dry land has been witnessed often.

36. When the law of gravitation is taken for granted, and applied to the actual conditions of our own planet, one of the consequences to which it leads is, that the earth, instead of being an exact sphere, must be flattened in the direction of its polar diameter, the one diameter being about thirty miles shorter than the other. Investigation showed this conclusion to be true in fact.

37. If Mr. H. were right, if, as he implies, our commerce, our very industrial existence would disappear, if we allowed neighbours, who envy us our commerce, to become our superiors in armament, how does he explain the fact that the Great Powers of the Continent are flanked by little nations infinitely weaker than ourselves, yet having a *per capita* trade equal to, and in most cases greater than ourselves ?

38. Until the beginning of the nineteenth century men of science were sceptical about the reality of meteorites (or "thunderbolts," as they used to be called). In 1802-1803, however, the observations of Howard and Biot secured the recognition of meteorites as facts. The next problem was to explain them. Geologists offered the explanation that the meteorites are of terrestrial origin, urging that they might be thrown up by volcanoes. Astrono-

mers suggested a lunar origin; they might be thrown off by volcanoes on the moon. Chladni, a German physicist, maintained that they came from the depths of cosmic space, and are of the the same origin as meteors or "shooting stars"—fragments of world-stuff ignited on entering the earth's atmosphere. Observations made by Brandes and Benzenberg showed that meteorites travel at a speed which could not have been acquired by projection from the moon. Moreover, there was no other evidence of the existence of lunar volcanoes. In support of the terrestrial origin of meteorites the geologists could only offer vague suggestions about the influence of electricity. Finally, observations of meteoric showers in 1833 and in 1866 showed that those meteorites all came from the same direction in cosmic space, a direction, moreover, determined by the stars, and not by the earth or by the moon. Chladni's explanation was accordingly accepted.

39. According to the suggested "iron law of wages" workmen's wages cannot rise above the minimum they absolutely require to live on. But this suggestion fails to account for numerous facts. Why is the rate of wages not the same in all trades? Must a skilled mechanic consume more food than a stone-breaker? Why are wages higher in America than in England? Does the American eat more than the Englishman? Why are wages higher to-day than a century ago? Have we greater appetites than our forefathers? Again, why are the wages of farm labourers lower in winter, when they are obliged to spend more on heating and

clothing, than in summer, when food is cheap and life in the country is easy?

40. Of 27 sterilized flasks containing an infusion of organic matter, and opened in pure Alpine air, not one showed putrefaction. On the other hand, of 23 similar flasks opened in a hayloft, only 2 remained free from putrefaction after three days. Tyndall concluded that the putrefaction was due to floating particles in the air.

41. When Pasteur had shown that the septic property of the atmosphere depended on minute organisms suspended in it, it occurred to Lister that one might prevent decomposition in a wound without excluding the air, namely, by applying to the wound, as a dressing, some material capable of destroying the life of the floating particles. Accordingly he used carbolic acid for the purpose. The wards of which he had charge in the Glasgow Infirmary were especially affected by gangrene, but in a short time after the introduction of the new dressing they became the healthiest wards, while other wards, separated only by a passage from his wards, retained their infection.

42. The cell-like character of certain animal tissues had been noted by students of minute anatomy. Schwann felt that this similarity could not be a mere coincidence. When Schleiden called his attention to the nucleus in the vegetable cell, Schwann thought that if there really is the correspondence between vegetable and animal tissues that he suspected, and if the nucleus is so important in the vegetable cell as Schleiden believed, the

nucleus should also be found in the ultimate particles of animal tissues. A close study of animal tissues under the microscope showed that opaque spots, such as Schleiden described, are really there in abundance. The location of these nuclei at regular intervals suggested that they are found in definite compartments of the tissue, as in the case of vegetables; indeed, the walls separating such cell-like compartments were in some cases visible. This convinced Schwann that all animal tissues are at first composed of particles resembling vegetable cells. This hypothesis is known as the cell theory.

43. On one occasion Darwin observed that in that part of the country where he lived, clover was abundant in the fields which were situated near villages, while the outlying fields were almost destitute of it. What now, he asked himself, is the connecting link between these facts? Some investigation of the matter convinced him that the three agencies which produced this result were humble-bees, mice, and cats. The bees fertilize the clover flowers, and thus make the plant abundant, the field-mice destroy the bees' nests, but the cats go out from the villages into the fields near by, and destroy the mice.

44. The recorded dates of ancient eclipses having been found to differ from those assigned by calculation, it has been surmised that the average length of a day may, in the meanwhile, have increased. If so, this is a phenomenon not accounted for by the causes formerly recognized as determining the rotation of the earth on its axis; and it may be

explained by the circumstance that the tides, through their friction, are reducing the rate of the earth's rotation, and thereby lengthening the day.

45. Two generations ago England adopted Free Trade, and her wealth has increased enormously since then. The Cobdenites maintain that Free Trade has been the cause of all this prosperity. On the other hand Germany and the United States have increased their wealth enormously since they adopted a protectionist policy. Tariff reformers maintain that this increased prosperity of Germany and the United States is due to protectionist policy, and urge its adoption in England.

46. It has been found that linnets^a when shut up and educated with singing larks—the skylark, woodlark, or titlark—will adhere entirely to the songs of those larks, instead of the natural song of the linnets. We may infer, therefore, that birds learn to sing by imitation, and that their songs are no more innate than language is in man.

47. The freshwater crayfish has a sense of smell, as is proved by the rapid way in which it retreats from strong odours. It occurred to one investigator that this sense might be located in the antennules or smaller feelers. It was found that a crayfish bereft of these appendages did not react to a strong odour, whereas in exactly the same conditions and to the same stimulus another crayfish with its antennules intact did actively respond. Hence it was concluded that the antennules are the seat of the organ of smell.

48. Two monkeys were made drunk, one with raw spirits, the other with matured spirits. The first became angry; it spat and it swore. The second was merely foolish and amiable in its intoxication. A week later the doses were reversed, and once more the monkey which had the raw whisky became quarrelsome, while the monkey which had the matured whisky was genial and good-humoured. This shows that the effects resulting from the drinking of raw spirits are far worse than those which result from drinking matured spirits.

49. It used to be supposed that all acids contain oxygen. Now if this assumption were true the combination of ammonia (which does not contain oxygen) with hydrochloric acid should give, as one of its products, water, which would contain the oxygen previously contained in the hydrochloric acid. But when ammonia and hydrochloric acid were actually combined it was found that only a slight dew was formed, which could be accounted for by the unavoidable imperfections in the process of mixing the ammonia with the acid. It was therefore concluded that hydrochloric acid does not contain oxygen.

50. Pasteur filled part of a bottle with wine, and sealed the bottle hermetically. Presently the wine changed into vinegar. Pasteur then submerged the bottle well under water and then withdrew the cork. The water rushed into the bottle and filled just one-fifth of the space originally occupied by air. Now, air is composed of one part of oxygen to four parts of

nitrogen. Moreover, the gas left in the bottle had all the properties of nitrogen. Pasteur therefore concluded that during the process of acetification oxygen is taken from the air.

51. According to the observation of Ptolemy (2nd cent. A.D.) the position of the sun among the stars, at the time of its greatest distance from the earth, was in longitude 65° . According to the observation of El-batani, the Arabian astronomer (c. 900), it was in longitude 82° . The difference is too great to be accounted for by inaccuracy of measurement. The solar system is probably itself moving through space.

52. At a meeting of geologists in England, Agassiz was asked what kind of fish would be found in fossil form in a particular stratum of the earth's crust. He thought for a moment, and then made a sketch of the fish which he believed would live at the time this geological stratum was formed. He did not understand the cheer with which his drawing was received by the company, until someone brought forward an actual fossil specimen which had just been found, and showed that it agreed perfectly with the sketch which Agassiz had created from his own knowledge of what characteristics a fish belonging to a particular stratum ought to possess.

53. When Pasteur decided to experiment with the juice of grapes he prepared 40 flasks of a capacity of 250 to 300 cc., and filled them half full with filtered grape-must, which remained uncontaminated, although the curved neck of the flasks remained open. In a small quantity of water he washed some grapes, grapes and stalks together,

and the stalks separately. The washing water collected the dust upon the surface of the grapes and the stalks, and it was seen under the microscope that this water contained a multitude of minute organisms resembling those of fungoid spores, alcoholic yeast, etc. Ten of the 40 flasks were preserved for reference. In 10 of the rest some drops of the washing water were introduced. In a third series of 10 flasks a few drops of the same liquid were put after it had been boiled. In the 10 remaining flasks were put some drops of grape-juice taken from the inside of a sound grape. The results were as follows. The first 10 flasks containing the grape-must^t boiled in pure air did not show any organisms. Those in the second series containing the washing water showed an alcoholic fermentation after forty-eight hours. The third series of flasks, containing washing water which had been boiled remained unchanged, like the first series. The fourth series, containing the juice of the interior of sound grapes, remained equally free from change. These facts show that the fermentation is caused, not by something inside the grapes, but by something outside them.

54. One day while Galen was feeling the pulse of a female patient someone entered and related that he had just been to the theatre where he saw Pylades dance. Galen noticed a sudden quickening of his patient's pulse, and he suspected that she was lovesick. When she came again next day, Galen had purposely arranged that someone should enter and say that he had seen Morphus dancing.

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This and a similar test on the third day produced no marked quickening in the woman's pulse. But it bounded again when on the fourth day Pylades' name was mentioned once more.

55. Sachs found that when light was excluded from a plant then, although all other conditions remained the same, no starch was formed; but when the plant was exposed to light again, then there was a renewed formation of starch. Similarly, when certain portions of the leaves of an illuminated plant were covered with black paper, then no starch was formed in those portions. Sachs concluded that starch is formed in plants by the decomposition of carbon-dioxide gas in chlorophyl under the influence of light.

56. Schwabe discovered that sun-spots reached a maximum once in approximately ten years. Lamont found that magnetic storms showed a periodicity of about ten years. Sabine discovered independently that magnetic disturbances reached a maximum of violence and frequency at intervals of about ten years. He noted, moreover, the coincidence between the period of magnetic storms and that of sun-spots; and showed that, according to the available data, the two cycles of change agree in duration and phase, maximum corresponding to maximum, and minimum to minimum. He concluded that there was some connection between them, though he could not explain the nature of the connection.

57. When Pasteur announced his discovery of a preventive vaccine against anthrax, the president

of an agricultural society, realizing the importance of the subject, furnished 48 sheep, 2 goats, and 10 head of cattle for a public test. Accordingly, 24 sheep, 1 goat, and 5 cattle received two preventive inoculations with an interval of twelve days between them. After another interval of two weeks all the 60 animals were inoculated, a protected and an unprotected one alternately, with an extremely virulent culture of anthrax microbes. The animals were then left together in one enclosure. Two days later a crowd of veterinary surgeons, farmers, and others came to see the result. Scattered about the enclosure, dead, dying, or sick unto death, lay all the unprotected animals, while all the protected (or previously vaccinated) animals stalked about unconcernedly in good health.

58. It had long been observed that when animal or vegetable matter had lain in water long enough to undergo decomposition the water became filled with microscopic creatures. This would tend to show either that the water, or the animal or vegetable substance, contained the germs of these minute organisms, or else that they were generated spontaneously. It was known that boiling killed these animalcules. Needham, therefore, thought that if he first heated the meat or vegetables, and also the water containing them, and placed them in hermetically sealed jars, and if the animalcules still appeared, then it would prove that they had been generated spontaneously. Accordingly he made such experiments, always with the same result—after a few days the water swarmed with these

creatures. But Spallanzani was not satisfied with Needham's experiments. The heating might have been insufficient to kill the germs, or the sealing process might not have excluded the air completely. He therefore first sealed the glass vessels hermetically, and then boiled them for three-quarters of an hour. No animalcules made their appearance in this case.

59. During the Spanish-American War the American troops suffered great losses from yellow-fever. A commission was appointed to investigate the causes. It was thought likely that yellow-fever, like malaria, was spread by mosquitoes which had bitten patients suffering from the fever. Dr. L. accordingly allowed himself to be bitten by such a mosquito. He contracted the disease, and died within a few days. Next, three volunteers slept for twenty nights in a small, ill-ventilated room screened from mosquitoes, but containing furniture and clothing which had been in contact with yellow-fever patients, some of whom had died of the disease. None of the volunteers contracted the disease. Then a similar room was divided by a wire screen, and mosquitoes which had bitten yellow-fever patients were admitted on one side only of the screen. One of the volunteers entered this section, and allowed the mosquitoes to bite him. He had an attack of yellow-fever. Two volunteers who stayed on the other side of the screen, and were thus protected from mosquito bites, remained in perfect health.

60. In 1861 there died at the Bicêtre a patient who for twenty years had been without the power

of speech, apparently through loss of memory of words. An autopsy revealed that a certain convolution of the left frontal lobe of his cerebrum had been totally destroyed by disease, the remainder of the brain being intact. Broca held that this case pointed strongly to a localization of the memory of words in a definite area of the brain.

61. The annals of Iceland show that hundreds of years before vaccination was heard of, that island was wont to enjoy intervals of exemption from epidemics of small-pox—intervals of several decades in succession. If modern communities have similar intervals of exemption, it is a fallacy to credit their good fortune to the practice of vaccination.

62. The difference between nations cannot be due simply to natural selection. You cannot show that the natural obstacles to human life differed much between Sparta and Athens, or between Rome and Athens. And yet Spartans, Athenians, and Romans were essentially different from one another. Old writers fancied that differences of climate and of other physical conditions produced racial differences. But experience refutes this. The English immigrant lives in the same climate as the Australian or Tasmanian, but he does not become like them. The Papuan and the Malay live now, and have lived for ages, side by side in the same tropical regions, and yet are very different from each other. We find like men in unlike places, and unlike men in like places. Climatic and other physical conditions are, therefore, not the forces that make nations.

63. It was long known that light is a detriment to the preservation of milk. But until recently it was not known which of the rays did the mischief. Dr. P. put sterilized and unsterilized milk in uncoloured glass bottles, in red glass bottles, in orange-coloured glass bottles, and in glass bottles of the other colours of the spectrum. He then placed all the bottles in the light for a whole day. It was found, at the end of the day, that both kinds of milk in the red glass bottles were fresh, even the unsterilized milk being good still for many hours. But the milk in all the other bottles had "turned" more or less; the milk in the bottles having the colours of the violet side of the spectrum had "turned" most of all. Red rays, therefore, appear to be beneficial to the preservation of milk, the other rays being more or less beneficial, or more or less injurious, according as they are nearer to the red or nearer to the violet end of the spectrum.

64. In 1909 the Midland Agricultural and Dairy College tested the value of applying certain fertilizers to pasture land used for dairy cows. Two plots of pasture land, *A* and *B*, each four acres in area, were fenced off, and both plots were dressed with 10 cwt. of ground lime per acre. Plot *A* received nothing else. Plot *B* received an additional dressing of 4 cwt. superphosphate and $1\frac{1}{2}$ cwt. sulphate of potash per acre. Neither plot received any further dressing during 1909-1912. Two lots of cows were drafted on to the plots each year early in May, and were kept there continually as long as there

was any grass, no other food being given. At the end of each fortnight the two lots were changed over, those on plot *A* going on to plot *B*, and vice versa. The net increase of profit on milk for plot *B* was an average of over £30 per annum for 1909-1912. In 1913 the test was repeated, the treatment of the plots being reversed. And the result is now similarly favourable to plot *A*.

65. The great famine in Ireland began in 1845, and reached its climax in 1848. During these years agrarian crime increased rapidly, and in 1848 was more than three times as great as in 1845. After this time it decreased with the return of better crops, and in 1851 was only 50 per cent. more than in 1845. Evidently there is a close connection between famine and agrarian crime.

66. If an active leaf be submerged in water contained in a glass vessel and exposed to the light, then bubbles may be seen coming from the surface of the leaf and rising through the water. (The water is only a device by which the bubbles of gas may be seen.) If the leaf is very active, the bubbles are numerous. If the light is diminished gradually, the bubbles become fewer, and eventually cease altogether. If next the light is increased again gradually, the bubbles reappear, and become more and more numerous as the light increases. This shows that the activity of the leaf is dependent upon light.

67. If we breathe on a cold metal or stone moisture condenses on it. The same phenomenon appears on a glass when ice-water is poured into it, and on

the inside of windows when the air outside gets colder suddenly. We may therefore conclude that condensation of moisture on a surface is due to its being colder than the surrounding air.

68. One objection to the views of those who, like Mr. Gulick, believe isolation itself to be a cause of modification of species deserves attention, namely, the entire absence of change where, if this were a *vera causa*, we should expect to find it. In Ireland we have an excellent test case, for we know that it has been separated from Britain since the end of the glacial epoch, certainly many thousand years. Yet hardly one of its mammals, reptiles, or land molluscs has undergone the slightest change, even although there is certainly a distinct difference in the environment, both inorganic and organic. That changes have not occurred through natural selection is perhaps due to the less severe struggle for existence owing to the smaller number of competing species; but if isolation itself were an efficient cause, acting continuously and cumulatively, it is incredible that a decided change should not have been produced in thousands of years. That no such change has occurred in this and many other cases of isolation seems to prove that it is not itself a cause of modification.

69. The process of nitrate production (nitrification) was formerly supposed to be entirely chemical. But in 1877, S. and M. showed that it was brought about by bacteria. A stream of sewage was made to trickle slowly down a column of sand and lime-

stone. For the first twenty days the ammonia in the sewage remained unaltered, then it began to change into nitrate, and finally the issuing liquid contained no ammonia, but only nitrate. S. and M. contended that, if the process of nitrification was purely chemical, the delay of twenty days before the ammonia was transformed into nitrate was inexplicable, but if it was bacterial then time would be required for these organisms to grow. As a further test some chloroform vapour was added. The nitrification ceased. But it commenced again when the chloroform was removed, and turbid extract of fresh soil was added.

70. In order to explain the invariability of the planetary periods it has been suggested that there is a vortex of attenuated matter moving with the planets, and therefore offering no resistance to their motion. But observations of Halley's comet have led to the repudiation of this suggestion. For Halley's comet revolves in the opposite direction to that of the planets, and therefore against the alleged vortex. Now, if the comet had to make head against such a current, it would steadily lose the tangential velocity which keeps it at a certain distance from the sun, and consequently would gradually draw nearer to the sun, and eventually collide with it. But no such approach to the sun has been detected in the long series of observations of Halley's comet.

71. Tyndall showed that in an hermetically closed box in which the air was "optically pure," that is, entirely free from all floating particles, putrescible

liquids in test-tubes, previously sterilized, could be exposed indefinitely without spoiling. But after admitting the outside air, even for an instant, the liquids in the test-tubes became spoiled within a few days and full of micro-organisms.

72. Dogs are liable to a fatal disease called rabies, which they transmit by their bite. When communicated to man this disease is known as hydrophobia. The specific virus of the disease is found in the saliva and salivary glands of the infected animal (hence the transmission by a bite), but also in the spinal cord of the infected animal. Pasteur showed that inoculations with an emulsion of such a spinal cord reproduced the disease in dogs and rabbits. He also discovered methods of preparing such emulsions of varying intensity or virulence. He inoculated some dogs with emulsions of increasing strength. The dogs treated in this way survived when affected by strong virus, which proved fatal in other dogs. Relying on these results, Pasteur inoculated human beings suffering from hydrophobia, using on successive days virus of increasing intensity. The mortality rate among patients so treated was considerably lower than among those not so treated.

73. It was well known that a falling body moves faster and faster as it travels through space. Galileo set himself to examine how this increase of velocity occurs. If he had worked by the Baconian method, he would have made endless experiments on falling bodies, till relations forced themselves on his notice. He did nothing of the kind. He thought over the facts, and made a guess at a possible law. He

surmised that the speed of a falling body might be proportional to the *distance* fallen through. He reasoned out the consequences of this supposition, and found that they were self-contradictory. Accordingly, he tried a different supposition, namely, that the speed varied as the *time* of the fall. Here the consequences deduced were consistent; the suggestion was worth testing. Owing to the lack of suitable apparatus he could not put his suggestion to a direct test. He therefore took one of its consequences (which he had obtained by mathematical reasoning)—the consequence, namely, that the distance fallen should be proportional to the square of the time. He made a falling body run down an inclined plane, and measured (by means of a new kind of water-clock) the times taken to run over marked distances on the plane. Small divergences in individual cases appeared; but, on the average, his results showed that the distances traversed were proportional to the squares of the times of fall. No other supposition could account for these results. Galileo accordingly considered his second surmise to be accurate.

74. Is air a chemical combination of nitrogen and oxygen? If it is not, then the particles of these two gases will be independent entities, existing side by side, the lighter (nitrogen) particles moving more rapidly than the heavier (oxygen) particles, and consequently capable of being separated by a merely mechanical process. For if we could pass air through a sieve with very small meshes—small enough to bear comparison with the actual size of the particles, and not large enough to allow

the whole mixture of particles to pass *en masse* through the interstices—then more of the light than of the heavy particles would get through in a given time, because the light particles are moving the more rapidly. The air which passed through such a sieve ought consequently to be richer in nitrogen, and the air which was left behind ought to be richer in oxygen. The sieve may be any substance with extremely minute pores, such as unglazed porcelain; and when air is drawn through a glass tube containing a plug of some such fine-pored material it is found that the air drawn out of the tube contains more nitrogen than the normal proportion, and there is left behind air containing more than one-fifth of its volume of oxygen. Such a purely mechanical separation as this proves that the nitrogen and oxygen in air are not chemically combined.

75. In 1892, that is before the suffrage was given to the women of Australia and New Zealand, the infant mortality rates per 1,000 births were: Australia 106, New Zealand 89. During the years following the granting of woman's suffrage there was a reduction in the infant mortality rate, which in 1912 was only 72 per 1,000 births for Australia, and 51 for New Zealand. Dr. T. concludes from this that the reduction was due to woman's suffrage. But this common kind of fallacy might easily have been avoided by noting that in England and Wales the infant mortality rate per 1,000 births was 148 in 1892, and only 95 in 1912. Woman's suffrage has evidently no influence on the mortality rate of infants.

76. H. and W. were studying the effect of nitrates on plant growth, and found that the amount of growth of cereals like barley and oats increased as the nitrate supply increased, and was, in fact, directly proportional to the amount of nitrate. In the case of peas and allied plants, however, no sort of proportionality could be traced. The plants did sometimes as well (or better) without nitrate as with it, but sometimes failed altogether. Chemical analysis showed that the quantity of nitrogen present in the cereal crops was just about the same as that applied to the soil, while the quantity present in those peas which made any growth was much greater. These peas must, therefore, have got some of their nitrogen from the air. But why had not all the peas done so? H. and W. suggested that bacteria might be the active agents here, as they knew that the nodules (the little swellings on the roots of the peas) contained bacteria, and also that some bacteria could take in gaseous nitrogen and use it. To test the matter peas were sown in sterilized sand (i.e. sand baked so as to kill all living organisms it contained) holding mineral food, but no nitrogenous food. These made little growth and developed no nodules. Other peas were sown in similar sand, but with the addition of a water extract containing organic matter. These made excellent growth and had many nodules. But if the water extract was first boiled, it had no effect in increasing growth. This showed that peas can associate with certain bacteria so as to draw on the stores of nitrogen in the air.

77. If after the Great War the democratic forces in Germany should triumph over the Junkers and get possession of the German Government, superficial people will probably maintain that the political revolution and the resulting progress were the direct result of the war, and may thus seek to justify the suffering and devastation which it caused. The steady growth of German Social Democracy during the past generation, the fact that by 1912 the Social Democrats had secured 34 per cent. of the total German votes, and that the continuance of such progress would inevitably have given them the control of the Government within a few years, will probably be lost sight of. Yet the triumph of democracy will be due primarily to these intellectual forces and to the work of education, propaganda and organization which the Social Democrats have carried on, year after year, and which the cruder methods of the Junkers were unable to resist.

78. Professor Loeb has shown that some animals, exposed to a ray of light, turn either towards or away from the source of light; and he has applied to such behaviour the term "heliotropism," one long used by the botanists to denote the bending of plants towards the light. Hence, without more ado, he speaks of the "establishment of the identity of the reactions of animals and plants to light," and reasons as follows: "We have seen that, in the case of animals which possess nerves, the movements of orientation toward light are governed by exactly the same external conditions, and depend in the same way upon the external form

of the body, as in the case of plants which possess no nerves. These heliotropic phenomena consequently cannot depend upon specific qualities of the central nervous system." . . . That is to say—having extended to certain reactions of animals the name "tropism," which had been used to denote certain plant-reactions to which they bear a purely external and superficial resemblance, Professor Loeb holds himself justified in regarding reactions of these two classes as essentially similar or identical, although it is well known to him, as to everybody else, that they differ profoundly, if only in that a complex nervous system plays an essential part in the animal reactions, but is absent from the plants.

79. In Glasgow, the general death-rate is twice as high in one-room apartments as it is in houses of four rooms or more. Even in three-room houses it is 25 per cent. higher. In Edinburgh, where certain slum-areas were demolished, the general death-rate fell from 45 to 15 per 1,000 of the population. The following table shows the weight and height of boys of 5, 9, and 11 years from homes of 1, 2, 3, and 4 or more rooms :—

Number of Rooms,	Weight in Pounds.			Height in Inches.		
	5 Years.	9 Years.	11 Years.	5 Years.	9 Years.	11 Years.
1	37·2	51·4	60·0	39·0	46·5	50·1
2	38·6	53·1	62·2	39·9	47·6	50·9
3	39·5	54·8	64·5	40·7	48·2	51·7
4	40·1	56·6	66·2	41·4	48·9	52·4

The worse the housing conditions the more puny the children.

80. The firefly, a soft-bodied, slow-flying insect, is easily caught and injured, but it is not fit for food, and therefore, says the [current] theory, lest it should be injured or killed by mistake, it has a fiery spark to warn enemies—birds, bats, and rapacious insects—that it is uneatable.

The theory of warning colours is an excellent one, but it has been pushed too far. We have seen that one of the most common fireflies is diurnal in habits, or, at any rate, that it performs all the important business of its life by day, when it has neither bright colour nor light to warn its bird-enemies; and out of every hundred species of insect-eating birds, at least ninety-nine are diurnal. Raptorial insects, as I have said, feed freely on fireflies, so that the supposed warning is not for them, and it would be hard to believe that the magnificent display made by luminous insects is useful only in preventing accidental injuries to them from a few crepuscular bats and goatsuckers. And to believe even this we should first have to assume that bats and goatsuckers are differently constituted from all other creatures; for in other animals—insects, birds and mammals—the appearance of fire by night seems to confuse and frighten, but it certainly cannot be said to *warn*, in the sense in which that word is used when we speak of the brilliant colours of some butterflies, or even of the gestures of some venomous snakes, and of the sounds they emit.

81. For centuries, and until quite recently, it was believed that the antidote to scurvy lay in vegetable acids. Scurvy grass was sought by the older voyagers, and finally lime-juice was made and remains a legal necessity for ships travelling on the high seas. Behind this belief lies a vast amount of evidence, but a full consideration of this evidence is beset with immense difficulties. For instance, although it is an undoubted fact that with the introduction of lime-juice scurvy was largely diminished, yet it is apt to be forgotten that there were other causes which might have contributed to this result ; for at the same time sea voyages were being largely reduced by steam power, and owners were forced to provide much better food for their men.

82. Certainly nations did not originate by simple natural selection, as wild varieties of animals may perhaps arise in nature. You could not show that the natural obstacles opposing human life much differed between Sparta and Athens or, indeed, between Rome and Athens; and yet Spartans, Athenians, and Romans differ essentially. Old writers fancied that the direct effect of climate, and the sum total of physical conditions varied man from man, and changed race to race. But experience refutes this. The English immigrant lives in the same climate as the Australian or Tasmanian, but he has not become like those races. The Papuan and the Malay live now, and have lived for ages, side by side in the same tropical regions, with every sort of diversity. Even in animals the direct efficacy of physical conditions

is overrated. Borneo and New Guinea, as alike physically as two distinct countries can be, are zoologically as wide as the poles asunder; while Australia, with its dry winds, its open plains, its stony deserts, and its temperate climate, yet produces birds and quadrupeds which are closely related to those inhabiting the hot, damp, luxuriant forests which everywhere clothe the plains and mountains of New Guinea.* That is, we have like living things in the most dissimilar situations, and unlike living things in the most similar ones. Nor can we doubt that we find like men in contrasted places, and unlike men in resembling places. Climate clearly is *not* the force which makes nations, for it does not always make them, and they are often made without it.

83. In a paper recently read before the Royal Society of Arts, Mr. Baker gave a short account of the industrial uses to which radium is at present put. Radium residues left over after treatment of the ores may or may not improve the growth of plants, according to the materials other than radium contained in them, but if the metals have been removed during the process of extraction of the radium the residue in suitable quantities appears to facilitate growth. In the discussion which followed the reading of the paper, it was pointed out that in much of the plant growth work which had been done with radium, sufficient care had not been exercised to enable it to be affirmed with certainty that the increased growth found in some cases was not due to the nitrates and phosphates

in the residues, rather than to the radium. This is a point that requires to be cleared up.

84. Koch found that, while guinea-pigs, mice, and other animals were killed by inoculation with anthrax, birds were not affected by it. Now, Pasteur had shown that the microbe of anthrax does not develop at a temperature of 44°C . The temperature of birds being $41-42^{\circ}$, may it not be (thought Pasteur) that the fowls are protected by their warm blood, and that their vitality helps them to bridge over the small gap between 41° and 44°C .? If so, then by cooling its blood a fowl should become vulnerable to the anthrax parasite. Accordingly a hen was inoculated with anthrax blood and placed with its feet in water at 25° . The blood of the hen got cooled to 37° . After 24 hours it was dead, and its blood was full of anthrax bacteria. Another hen similarly inoculated and cooled until it was in a high state of fever was then taken out of the water, wrapped in cotton wool, and placed in an oven at 35° . Its strength gradually returned, and in a few hours it was quite well again. Hens killed after being thus saved showed no trace of anthrax organisms.

85. In Athens, where industry was regarded with comparative respect, there grew up an industrial organization which distinguished the Athenian society from adjacent societies while it was also distinguished from them by the democratic institutions that simultaneously developed. Turning to later times, the relation between a social regime predominantly industrial and a less coercive form

of rule than is usually found in societies which are predominantly militant is shown by the Hanse towns, by the towns of the Low Countries out of which the Dutch Republic arose, by Norway, by the United States, by Britain, and the British colonies. Along with wars less frequent, and along with an accompanying growth of agriculture, manufacture, and commerce, beyond that of Continental States more military in habit, there has gone in England a development of free institutions. As further implying that the two are related as cause and consequence, there may be noted the fact that the regions whence changes towards greater political liberty have come are the leading industrial regions, and that rural districts, less characterized by constant trading transactions, have retained longer the earlier (militant) type with its sentiments and ideas.

The pervading traits in which the industrial type differs so widely from the militant type, originate in those relations of individuals implied by industrial activities, which are wholly unlike those implied by militant activities. All trading transactions are effected by free exchange. For some benefit which *A*'s business enables him to give, *B* willingly yields up an equivalent benefit. This relation in which the mutual rendering of services is unforced and neither individual is subordinated, becomes the predominant relation throughout society in proportion as the industrial activities predominate. Daily determining the thoughts and sentiments, daily disciplining all in asserting their own claims

while forcing them to recognize the correlative claims of others, it produces social units whose mental structures and habits mould social arrangements into corresponding forms. There results a type of society characterized throughout by the same individual freedom which every commercial transaction implies. In the militant type, on the other hand, the nation is essentially an army, sometimes mobilized, at other times quiescent. And as the soldier's will is so suspended that he becomes a mere instrument of his officer's will, so the citizen of a militant regime is overruled by the Government.

86. The most surprising thing about the Mayas is that they developed their high civilization in what are now the hot, damp, malarial lowlands where agriculture is impossible. A hundred miles away far more favourable conditions now prevail. In the past these more favourable localities were occupied by people closely akin to the Mayas, yet civilization there never rose to any great height. In explanation of these peculiar conditions three possibilities suggest themselves. (1) We may suppose that the Mayas were able to carry on agriculture under conditions with which no modern people can cope; that they chose the worst place even though far better places lay close at hand and were occupied by allied peoples few in numbers and backward in civilization; that for a thousand years they were able to preserve their energy under the most debilitating climatic conditions, immune to the many fevers which to-day weaken the dwellers there.

(2) Or we may suppose that in the time of the Mayas tropical diseases were less harmful than they are now. (3) Lastly, we may suppose that the climate has changed—the dry conditions which prevail a little farther north may have prevailed in the Maya region when the Mayas attained eminence. That climates do sometimes change is evidenced by conditions in Palestine. In Palestine the rainy zone once extended at least fifty miles south of its present limit, but the zone of cyclonic storms has at certain periods suffered a shift equatorward. Now if the Maya region has undergone a corresponding climatic change the explanation would be simple. A longer dry season would diminish the amount of vegetation and cause scrub to take the place of dense forest. Agriculture would then be comparatively easy, and fevers would greatly diminish.

87. At the time of the American Revolution many Loyalists left their homes in Georgia and other southern States and sought the British territory of the Bahamas. Other colonists also came from Great Britain. Now, after from three to five generations, the new environment has produced its full effect, and the result has been disastrous. Compare the Bahamas with Canada. The same sort of people went to both places. To-day the descendants of the Loyalists in Canada are among its strongest elements. In the Bahamas the descendants of the same type of people show a larger proportion of degenerates than can be found in any other Anglo-Saxon community. The average white

farmer there is scarcely ahead of the average negro. This shows that when the white man migrates to climates less stimulating than those of his original home he deteriorates. And naturally so. For he loses in both physical and mental energy. This leads to carelessness in matters of sanitation and food, and thus gives greater scope to the diseases which under any circumstances would find an easy prey in their weakened bodies. The combination of mental inertia and physical weakness makes it difficult to overcome the difficulties arising from isolation, from natural disasters, or from the presence of an inferior race, and this in turn leads to ignorance, prejudice, and idleness. Thus there arises a vicious circle which keeps on incessantly. From its revolving edge a part of the community is thrown off as "poor whites" or "crackers," in proportion to the enervating effect of the climate. If white men lived a thousand years in Egypt it seems probable that a large proportion would degenerate.

88. According to Renan the fear of conquest and the consequent preparation for war are a necessary spur to human progress. But this is erroneous. In Russia, in England and in other countries where the armament competition is acute there are myriads of people who live below the bread-line. In America, on the other hand, conditions are far better. Even European countries like Norway, Sweden, Denmark, and Switzerland, which during the past fifty years have not been under the fear of war, have also made great progress. The fear of conquest has really retarded the progress

of the Great Powers. Their armament competition has eaten up two-thirds of their revenues, to the detriment of education and social reform.

89. It is maintained by some that good government is impossible so long as it is permitted to Parliament and the Press to make criticisms and disclosures that may lower the rulers in the eyes of the people. Well, there are no complaints against the Government in Turkey—no motions in Parliament, no *Morning Chronicles*, and no *Edinburgh Reviews*. Yet of all countries in the world, it is in Turkey that revolts and revolutions are most frequent. It is so far from true that no good government can exist consistently with such criticisms and disclosures, that no good government can exist without them. It is quite obvious to all who are capable of reflection that by no other means than lowering the governors in the estimation of the people can there be hope or chance of beneficial change. To infer from this wise endeavour to lessen the existing rulers in the estimation of the people, a wish of dissolving the Government, is either artifice or error. The physician who intentionally weakens the patient by bleeding him has no intention that he should perish.

The greater the quantity of respect a man receives, independently of good conduct, the less good is his behaviour likely to be. It is the interest, therefore, of the public, in the case of each, to see that the respect paid to him should, as completely as possible, depend upon the goodness of his behaviour in the execution of his trust. But it is, on

the contrary, the interest of the trustee that the respect, the money, or any other advantage he receives in virtue of his office should be as great, as secure, and as independent of his conduct as possible. Soldiers expect to be shot at. Even so public men must expect to be attacked, and sometimes unjustly. They must cultivate the habit of considering their conduct as exposed to scrutiny, while the people at large must keep alive the expectation of witnessing such attacks, and exercise vigilance in looking out for them. After all, the friends and supporters of a Government have always greater facility in supporting and strengthening it than its adversaries have for lowering it.

90. The star Algol shines with a brightness equal to that of the Pole Star for nearly two and a half days, and then suddenly its light is reduced. In about four and a half hours the star's brightness is diminished by about two-thirds, and three and a half hours later it regains its former intensity, which continues for another fifty-nine hours. These variations succeed one another with absolute regularity. To explain the sudden reduction in the light of Algol, Goodricke suggested that a dark body is revolving round the star, and periodically comes between us and it, thus causing a partial eclipse in each revolution. As a star can never be seen as anything but a point of light, it is impossible to distinguish any outlines of a dark body upon a luminous disk, such as is seen, e.g., during partial eclipse of the sun by the moon. But Goodricke's suggestion was accepted because it alone accounted

for the observed variations. More than a century later, however, it was pointed out that if Algol has a dark companion, then the two bodies must swing round their common balancing point, or centre of gravity. Hence, when the dark body is moving towards us before passing in front of the bright globe, the latter must be swinging back, and when the dark sphere is receding after the eclipse, the bright star must be approaching us. Algol must therefore alternately recede and approach in each cycle of its periodic changes of brightness. By means of the spectroscope Prof. Vogel showed, in 1888, that these periodic backward and forward movements of Algol do occur. The dark companion of Algol has never been seen, perhaps never will be, yet astronomers have no doubt of its existence. Some twenty other stars are now known to fluctuate in light, and each is believed to have a dark satellite, as Algol has.

91. In Davy's experiments with the decomposition of water by galvanism it was found that, besides oxygen and hydrogen, an acid and an alkali were developed at the two opposite poles of the machine. Davy conjectured that the glass containing the water might suffer partial decomposition, or some foreign matter might be mingled with the water, and the acid and alkali be disengaged from it. He substituted gold vessels for glass; but it made no difference. Evidently the glass was not the cause. He next employed only distilled water. There was a marked reduction in the quantity of acid and alkali evolved; but they were still there.

He next suspected the perspiration from the hands touching the instruments, as it would contain common salt, which would decompose into an acid and an alkali under the action of electricity. After carefully avoiding manual contact, only slight traces of acid and alkali appeared, such as might be traced to impurities from the atmosphere, decomposed by contact with the apparatus. He next put the machine under an exhausted receiver. It evolved no acid or alkali.

92. The inquiry into the cause of sound had led to conclusions respecting its mode of propagation, from which its velocity could be precisely calculated. The calculations were made; but when compared with actual observations, although the agreement was sufficient to confirm the general correctness of the suggested mode of propagation, yet the velocity was rather greater than that demanded by the theory. Eventually, however, Laplace struck on the happy idea that the excess velocity may be due to the heat developed in the act of condensation which takes place at every vibration by which sound is conveyed. The matter was subjected to exact calculation, and the result was at once a complete explanation of the phenomenon under consideration and a striking confirmation of the general law of the development of heat by compression, under circumstances beyond artificial imitation.

GROUP L

PROBABILITY AND CHANCE

1. In what sense can probability be said to be (a) objective, (b) subjective?

Consider whether an estimate of probability can be rendered incorrect by additional knowledge of matters of fact. To what extent may all induction from a limited number of observations be said to rest on probability?

2. Compare the way in which you would calculate the chances that a normal die, when thrown, will show a particular number, with the way in which you would calculate the chances in favour of a man's recovery from a certain illness. Is the underlying principle the same in the two cases? If not, explain the difference.

3. Explain (with special reference, say, to fire insurance) how calculations of probability may save us from some of the consequences of the irregularities of details by invoking the regularity of the average.

4. State and illustrate the principle by the help of which the doctrine of chances enables us to ascend from events to their causes. To what extent does the calculation of chances help to eliminate coincidences that are merely casual?

5. Out of a thousand children who are ten years old, seventy die before reaching the age of twenty-five. Let A, B, and C stand for three children, each of them ten years old. Calculate the probability (a) that B will reach the age of twenty-five, (b) that at least one of the three will live to the age of twenty-five, (c) that both A and B will reach the age of twenty-five.

6. Four boats, P, Q, R, and S, ply regularly between two seaports, X and Y. Calculate the probability that a passenger, who has gone from X to Y and back, made (a) his outward passage in either P or S, (b) both passages in R, (c) both passages in the same boat, (d) at least one passage in Q.

7. In my pocket I have two sovereigns, three single shillings, and six halfpennies, and I take out two of the coins at random. Calculate the chances that the two coins are (a) the two sovereigns, (b) a shilling and a halfpenny.

8. Five hens of the same strain (A, B, C, D, E) lay four eggs on a certain day. Calculate the chance (i) that A laid one of the eggs, (ii) that both B and C were among the layers, (iii) that a particular egg was laid by D.

9. A and B arrange to meet at the entrance of an exhibition, which, without their knowing it, actually has four different entrances, W, X, Y, Z. Calculate the probability (i) that A and B will meet at the same entrance; (ii) that they will meet at entrance Z; (iii) that A will arrive at entrance X and B at Y.

10. A, B, and C are members of a crew of five. Two of the crew are reported to be missing. Calculate the probability (i) that A is among the missing, (ii) that both B and C are missing, (iii) that A, B, and C are all safe.

11. It is said that the knowledge of the probability of an event gives no definite information about the next or any future occurrence of an event of that kind. Explain this view, and show the real nature and value of such knowledge.

12. X, Y, and Z are known to have been in a train-wreck in which a third of the passengers were injured. Supposing that no other information is available, calculate the probability (i) that X and Y, (ii) that X and Y and Z, (iii) that X, or Y, (iv) that X or Y, or Z, have *escaped* injury.

13. A, B, and C are respectively ten, twelve, and fourteen years of age. Supposing that of children who are ten, twelve, and fourteen years old, 7, 6, and 5 per cent. respectively die before attaining the age of twenty-five, calculate the probabilities that (i) A and B, (ii) A or B, (iii) A or B or C will survive till the age of twenty-five.

14. Examine critically the assertion that a judgment of probability is a statement of ignorance.

15. State the grounds upon which you would determine the chances in the following cases:—

(a) In two raffles with fifteen and twenty contributors respectively, and in each one prize, the chance that a person who joins both would win both prizes.

(b) In a raffle with twenty contributors and two

prizes, the chance of getting one or other of the prizes.

16. Unaware that his watch has stopped, Smith looks at it once in the course of twelve hours. Assuming that it takes him a whole minute to tell the time, calculate the probability that he will see the correct time.

17. What is the probability that the first two persons you meet were born on (a) the same day in the week, (b) a Sunday?

18. Two children who can only count up to 10 are asked to think of any number they like. What is the probability that they will both think of the same number?

19. A, B, and C are known to have been respectively 1st, 2nd, and 3rd class passengers on a boat which was wrecked with a loss of 30 per cent. of the 1st class passengers, 50 per cent. of the 2nd class passengers, and 70 per cent. of the 3rd class passengers. Calculate the chances of the safety of (i) A and B, (ii) A or B, (iii) A or B or C.

20. A, B, and C are known to have been passengers on a boat which was torpedoed with a loss of 80 per cent. of the 1st class passengers, 60 per cent. of the 2nd class passengers, and 70 per cent. of the 3rd class passengers. Supposing it be known that A travelled 1st class and B 2nd class, and that no other information is available for the time being, calculate the probability that (i) A and B are saved, (ii) C is saved, (iii) A or B is saved, (iv) one of the three at least is saved.

21. X, Y, and Z are known to have been on a

battle-cruiser when it was sunk. The battle-cruiser had a complement of a thousand men, of whom six hundred were either killed or drowned, and the rest picked up and taken prisoners, half of them being wounded. Calculate the probability (a) that X and Y and Z are among the survivors, (b) that X or Y is wounded, (c) that X or Y or Z is a prisoner but not wounded.

22. In certain experiments on thought-transference it was found that out of a series of a hundred attempts to name a card drawn out of a full pack of fifty-two cards sixty-five were successful. Could this be regarded, or under what circumstances could it be regarded, as evidence in favour of thought-transference?

23. Why is it better to take the mean of a number of observations than to trust one observation however carefully made?

24. In a given state of society a certain number of persons must put an end to their own life. This is the general law, and the special question as to who shall commit the crime depends upon special laws, which, however, in their total action, must obey the larger social law to which they are all subordinate. And the power of the larger law is so irresistible that neither the love of life nor the fear of another world can avail anything toward checking its operation.

25. Discuss the conceptions of *chance* and *accident*, and the question of their consistency with the universal reign of law; and comment on the following account:—

At the appeal of the managers of the Trim District School versus Mrs. Elizabeth Kelly, the question for decision was whether the woman's son, a master in the Trim School, died as the result of accident, arising out of, and in the course of, his employment, so as to entitle her to compensation under the Workmen's Compensation Act.

Respondent's son, against whom some of the inmates of the school had a grudge because he detected one who was guilty of theft, and because he prevented them playing a certain game in a shed attached to the school, was attacked by one or two boys with dangerous weapons. The man's skull was fractured in two places, and he died the same day.

The question was, was the attack by the boys on the teacher an accident, within the meaning of the Act, arising out of, and in the course of, his employment?

The county court judge in Ireland held that it was, and he awarded Kelly's mother, who was a dependent, £100 compensation. This view of the case was also taken by the Irish Court of Appeal.

Mr. Sankey, K.C., on behalf of the appellants, contended that as there was a clear conspiracy among the boys in the school to attack Kelly it was impossible to treat his death as the result of an accident arising out of, and in the course of, his employment. The fact that the assault was designed removed it from the category of an accident within the meaning of the Workmen's Compensation Act.

Lord Atkinson said design, if used in the sense of wilful, might apply to any assault, but it was an

entirely different thing where they had a conspiracy by a number of boys.

Lord Loreburn said he had had a great many of these cases to consider, and he always found his mind running into metaphysics—almost into theology—because nothing which happened was really accidental.

Lord Dunedin: Lord Young defined an act of God as that which no reasonable man would ever do. (Laughter.)

Mr. Ronan, K.C., for respondent, said Kelly was placed in a position where he incurred the displeasure of the boys, and the injury was due to the performance by him of the duty for which he was paid. The boys did not mean to kill Kelly.

GROUP M

MISCELLANEOUS FALLACIES

NAME the fallacies committed, or referred to, in the following passages, and explain their character.

1. A vacuum is impossible, for two bodies must touch if there is nothing between them.

2. It is not right for anyone to devote all his time to study, for if all people did so the world could not go on.

3. Dr. Woods, after a careful study of European History from 1450 to 1900, found that in the whole space of 450 years there were only two short periods, one of 10 years and another of 17 years, of universal peace on the Continent. This, according to the *Morning Post*, demonstrates that "it is war that is normal," not peace. With *Morning Post* Logic one could easily prove that red-headedness is the normal state of civilization, seeing that there must always have been a red head somewhere or other.

4. The story must be true. When he told it he was far from sober, and you know the proverb, *In vino veritas*.

5. There is not a single branch of education that when considered by itself can with truth be said to be indispensable. Can we therefore resist

the conclusion that a man may dispense with education altogether?

6. Mr. X must be among the eleven best cricketers in England, for he is a member of the champion county team.

7. Section A can be taken at the May or the September examination; Section B can be taken in September only. As this is September, I must take Section B.

8. An old woman having lost her sight consulted an oculist and agreed to pay him a certain sum if he cured her. The oculist visited her frequently and took something away each time. When he had taken all she had he cured her and demanded payment. But she refused to pay, saying: "I am still blind, for just before I lost my sight I saw various chattels in my house, and now, although you say I am cured, I cannot see anything in it."

9. Human life will at some time disappear from the earth, for all men must die.

10. To be wealthy is not to be healthy; not to be healthy is to be miserable; therefore, to be wealthy is to be miserable.

11. A man of perfect character cannot help doing what is right. But what is done from necessity is not done from choice, and what is not done from choice has no merit. A man of perfect character, therefore, does nothing meritorious.

12. When any condition of life is empty of evil, we easily imagine it to be full of good.

13. Some things against which the chances are

many thousands to one happen every day. Now things against which the chances are many thousands to one are improbable; on the other hand, what happens every day is probable. Improbable events are therefore probable.

14. The morning papers say that "money is much more plentiful in London to-day than it was yesterday." But this cannot be true, for we know that there is no more coin or bullion in London to-day than there was yesterday.

15. By faith we may believe that those who are known to be dead are not dead. For faith is a means of believing that which we know not to be true.

16. Mr. X declined to give anything to the Hospital Fund, saying that he could not afford to subscribe to all the charities to which he had been asked to contribute.

17. Any boy in the class would stand higher in the examination list if he received 15 per cent. more marks. If, therefore, the marks of all the boys be increased by 15 per cent., each boy will stand higher in the class list.

18. The holder of some shares in the lottery is sure to win a prize, and as I have some shares in the lottery I am sure to win a prize.

19. An import duty on sugar is beneficial to sugar-refiners, an import duty on corn is beneficial to corn-growers, an import duty on silk goods is beneficial to silk-weavers, and so forth. Now practically every member of the community is connected with some business or other, therefore a universal system

of protective duties would benefit the entire community.

20. Woman is justly entitled to participate in the government of the State. For the government of the State is only a kind of national house-keeping. And all admit that woman has a genius for house-keeping.

21. Any man will give his last shilling to protect the remainder.

22. Because good poems have grown out of the emotions felt by poets who loved flowers and birds, it does not follow that those who babble continually of birds and flowers write good poems.

23. If people are friends they will be just to one another, but people may be just to one another without being friends.

24. Although the magnificent person is liberal, it does not follow that the liberal person is magnificent.

25. Injustice implies unjust action, although unjust action does not always imply injustice.

26. Drink is often a cause of poverty, but to attribute poverty mainly to drink is to libel thousands of very respectable people who are poor.

27. We speak of a person as *a bad doctor* or *a bad actor*, although we should not call him *bad* in an absolute sense.

28. "Many's the time I've asked Josh what politics is, and all he can say is, 'It's what women can't understand.' There must be a power of politics in the world, for there's many things I can't understand."

29. The College staff must have been increased,

for there are two new members on the Professorial Council, and all members of the Professorial Council are members of the staff.

30. It is a mistake to suppose that because the members of the most civilized nations are distinguished for their domestic virtues, therefore the members of the most venerated homes make the most civilized society.

31. Gold and silver are wealth. Therefore the diminution of the gold and silver in the country by exportation is the diminution of the wealth of the country.

32. The House of Lords has two new members, because there are two new dukes, and all dukes are members of the House of Lords.

33. In going round the world westward we keep gaining time, and the whole trip would gain us a full day; therefore if we could make the whole journey in twenty-four hours it would really take us no time at all.

34. The fact that X is an incompetent mathematician does not prove that he is an incompetent man.

35. "Speaking of money," said the night watchman thoughtfully, "the whole world would be different if we all had more of it. It would be a brighter and a happier world for everybody."

36. Any prime number greater than 3 must differ by unity from a multiple of 6; now 61 and 59 differ by unity from a multiple of 6; therefore, 61 and 59 are prime numbers.

37. Sir Ernest said that lots of prominent lawyers

made observations without any object. Sir John retorted that he had been making observations with a definite object. Thereupon Mr. Justice Darling concluded that Sir John could not be a prominent lawyer."

38. The practice of suppressing part of the truth must be commendable. For tact is often shown by shutting one's eyes to unpleasant facts; and tact is universally commended.

39. The American does not discriminate between a constitutional monarchy and a despotism. All he knows is that a man who lives under a republic is his own master, therefore a man who lives under a king is not his own master.

40. Some prejudices must be rational, for they are shared by many people, as rational opinions always are.

41. No man need lament what no man can prevent, and since no man can prevent death, one should not lament it.

42. A war that is really just never fails to be popular. Now the late war was very popular with the English people; therefore it was a just war on the part of England.

43. Never pay a doctor's bill immediately. If you do he will think that he underestimated your value.

44. A politician, if he is to succeed, must be either very clever or very rich; and since Mr. X is neither poor nor stupid he is sure not to fail.

45. Sir John, our Unionist M.P., had a harder task, and, therefore, a more notable victory than

either Mr. Brown or Mr. Smith. For Mr. Brown was only opposed by a Liberal candidate, and Mr. Smith by a Labour candidate, while our Sir John had two rivals, a Liberal candidate and a Labour candidate.

46. To identify the verification of an hypothesis with the proof of it is to commit the fallacy of *consequens*.

47. Bentham was the victim of a common delusion. If a system will work, then the minutest details can be exhibited. Therefore, it is inferred, an exhibition of minute details proves that it will work.

48. Emergencies are best dealt with by unscrupulous men. For they stick at no trifles. And only those who stick at no trifles can cope successfully with emergencies.

49. All who attended the meeting were in favour of adult suffrage. But since X did not go to the meeting he must be opposed or indifferent to the extension of the franchise.

50. Only intelligent beings are responsible for what they do, and their responsibility increases with their intelligence. Now, some horses are more intelligent than some men. Some horses are, therefore, more responsible than some men.

51. Prof. Flint, in his lectures on *Theism*, says that the question in the theistic argument from causality is to prove the universe to have been an event—to have had a commencement. Accordingly, he proceeds to the examination of the universe in order to determine whether or not it bears the marks of

being an event. And because such an examination reveals mutability stamped upon every particular fact in the universe, even its apparently most stable formations—so that each may be treated as an event dependent on a preceding event, a phase in a universal process of transformation—he draws the conclusion that the universe as a whole is an event or effect in the same sense.

52. Royal Commissions are useless. For they are unnecessary if they recommend what the Government does mean to do, and they are ineffectual if they recommend what the Government does not mean to do.

53. Some historians begin by forming an opinion, and only afterwards look up the documents. The result frequently is that the text of the documents yields, bends, and accommodates itself to the preconceived opinion.

54. During an epidemic of smallpox the Jakutes saw a camel for the first time, and they declared it to be the hostile power that had brought the smallpox on them.

55. During the Great War there was a marked reduction in the amount of crime in the United Kingdom. Evidently war is a great moral tonic.

56. "The 7th Durhams," said the Colonel, "were in the trenches when there came rolling towards them the dreaded green-coloured gas. Men were running in front of it and falling. I had with me twelve signallers, and I said to them, 'It is no use running; come up on the parapet and sing a hymn.' They stood up and sang 'Abide with Me.' The

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cloud of death disappeared, and not a man was affected."

57. The proportion of inmates in our asylums who can read and write is very high, from which we may infer that education is among the causes of insanity.

58. It will be for ever impossible to persuade the people of Linguaglossa that they do not owe the salvation of their town to the intervention of their patron, St. Egidius. As was done at past eruptions, the townsfolk carried the crozier of the Saint in procession round the town and finally planted it on a rising spur of a mountain on the side of Linguaglossa nearest to Etna. When the lava stream reached this rising ground it divided and flowed into a neighbouring valley and thus did not enter Linguaglossa.

59. An illusion largely shared in Germany itself is that her material prosperity is a direct outcome of the military successes of 1866 and 1870, and her subsequent unification. As a matter of fact, Imperialism had little to do with the commercial and industrial rise of Germany. Many years' connection with German manufacturing life has convinced me that, though the Empire may have supplied an effective trade *label*, the real source of growth has been the inevitable outcome of modern economical developments of Europe as a whole, taken advantage of, in spite of tariff walls and heavy taxation, by the industrious qualities of the race, fostered by a century of education and careful industrial training.

60. Five years ago a first-class pair of nickel-plated skates cost \$15. To-day they can be obtained for \$4. Three years ago a second-grade pair of skates cost \$4. To-day they cost \$1.50. The decline of 70 per cent. in five years, and of 60 per cent. in three years, shows how protection cheapens prices.

61. Apropos of loss of friends, somebody was saying the other day, before Morgan, the great calculator of lives, that they had lost so many friends (mentioning the number) in a certain space of time, upon which Morgan, coolly taking down a book from his office shelf, and looking into it, said, "So you ought, Sir, and *three more*."

62. Effects sometimes follow and sometimes precede their cause. For instance, the dust raised by a motor-car follows it, while the air which it compresses is in front of it. It is therefore erroneous to define a cause as an invariable *antecedent*.

63. It is just the trained people who make the gravest mistakes. For example, it is the trained lawyer who gives bad legal advice involving great losses, and it is the professional doctor who makes a wrong diagnosis, which may have injurious or even fatal results. To avoid grave mistakes it is therefore best to consult untrained people.

64. Though the period of greatest prosperity and improvement of Great Britain has been posterior to that system of laws which is connected with the bounty, we must not on that account impute it to those laws. It has been posterior to the national debt. But the national debt has assuredly not been the cause of it.

65. There is nothing to say about such a book except that people who like this sort of thing will find in it the sort of thing they like.

66. *Cashier* : You will need to be identified, Madam.

Lady : My friend here will identify me.

Cashier : But I don't know her.

Lady : Oh, but I'll introduce you.

67. Nations are justified in revolting against a bad government, for every nation has a right to good government.

68. The Budget is fraught with dangerous consequences. For it is socialistic in tendency ; and socialism is the negation of faith, the destruction of family life, of property, of the Monarchy, of the Empire, and the end of all things.

69. If one told old Pinkerton of the *Daily Liar* that he was wrong about something he would point to his vast circulation as evidence that he must be right. If one still pressed the point he would again refer to his circulation to show how little it mattered whether his views were right or wrong.

70. Women and children ought not to be protected against long hours of work, because such protection involves an increase in the cost of labour.

71. On November 19, 1644, "a strange apparition of three suns" was seen in London. Lilly, like others, maintained that it portended some strange occurrence. He argued : "If there be any of so prevaricate a judgment as to think that the apparition of these three suns doth intimate no novel thing to happen in our own climate . . . I shall . . . conceive their brains to be shallow."

72. Certain African medicine-men held the view that lung-disease in cattle is caused by some disease-devils invading the lungs. They accordingly suggested that the best way of saving the surviving healthy cattle from the disease would be to let them eat up the diseased lungs of the dead cattle, thus eating up and destroying the little disease-devils that might otherwise attack them. The experiment was tried with remarkable success. The theory may therefore be said to have been verified.

73. Acts justifiable when the rights of individuals were not respected may not be justifiable now when we have the right of free speech and facilities for influencing public opinion.

74. The spread of education among the lower orders will make them discontented and unfit for their work. For such has hitherto always been the effect on those among them who have acquired some education.

75. Freedom is the natural right of man. It is therefore wrong to imprison any man.

76. The Early Church was a model of a perfect society, and in that Church, as we know, all property was in common. Private ownership, therefore, is wrong.

77. A must be heavier than B, because A weighs B down.

78. All Republics are liable to corruption. Look, for instance, at France and the United States. They are Republics, and they have both shown tendencies to corruption.

79. Citizens have a right to form themselves into

political organizations, and therefore civil servants have the right to do so.

80. Imprisonment is no deterrent. For at the last Quarter Sessions there was a score of men up for petty theft within six months or less of their coming out of prison for previous offences. Almost without exception they pleaded guilty and appeared glad to return.

81. "He talks with angels," one told me. "How know you that?" I said, sceptically. "He himself admits it." "But suppose he lies." "What! a man who talks with angels be capable of a lie?"

82. "You should say what you mean," the March hare went on. "I do," replied Alice hastily; "at least, I mean what I say—that's the same thing, you know." "Not the same thing a bit," said the Hatter. "Why, you might just as well say that 'I see what I eat' is the same thing as 'I eat what I see.'"

83. There is no such thing as colour really inhering in material bodies; it is altogether in the light. For colours are more or less vivid in proportion to the light; and if there be no light, then there are no colours perceived.

84. Jones must have plenty of money. For he has plenty of time; and "time is money."

85. Whatever is found in all prosperous countries but in no backward countries must be beneficial. But such is, or has been, the case with slavery, polygamy, public debts, pauperism, and crime. These must, therefore, be beneficial somehow.

86. There is much to be said in favour of cock-

fighting. It is popular in England, and England is a prosperous and glorious country. Moreover, cock-fighting gratifies the instincts of the birds, and clearly realizes the purpose of their spurs.

87. For many centuries it was believed, on the authority of Galen, that the human thigh-bone is curved. Vesalius discovered that it is straight. Sylvius would not believe that Galen could be wrong. He accordingly suggested that the thigh-bone in its natural condition is curved, but that it may have become straight as a result of the tight trousers worn at that time.

88. *Egyptologist*: There is nothing new under the sun. Recent excavations in Egypt have brought to light very old wires, which make it highly probable that telephones were already used by the Egyptians in the time of Pharaoh.

Assyriologist: The Assyrians and Babylonians were even more advanced than that. No wire has ever been discovered during excavations in Mesopotamia. This makes it highly probable that the ancient Assyrians and Babylonians were already familiar with wireless.

89. It is generally recognized by biologists that an animal should live about five times the length of the period it takes to mature. A dog, for instance, matures as a rule at 2 years, and dies at about 10. Now man matures at about 25 and should therefore live to about 125. Yet the average length of human life is only about 42. Obviously there is something wrong; and what is wrong is our meat-eating habits.

90. Dr. Livingstone was trying to dissuade an African sorcerer from his fetishistic ways of invoking rain. "You see," he said, "that after all your doings, it sometimes rains, and sometimes does not, exactly as when you do nothing at all." "But," replied the sorcerer, "it is just the same with you doctors. You give your remedies, and sometimes the patient gets well, and sometimes he dies, exactly as when you do nothing at all."

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